Field Book for Describing and Sampling Soils

Version 1.0

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ACKNOWLEDGMENTS

The science and knowledge in this document are distilled from the collective experience of thousands of dedicated Soil Scientists during the nearly 100 years of the National Cooperative Soil Survey Program. A special thanks is due to these largely unknown stewards of the natural resources of this nation.

Special thanks and recognition are extended to those who contributed extensively to the preparation and production of this book: The 75 soil scientists from the NRCS along with NCSS cooperators who reviewed and improved it; Tammy Nepple for document preparation and graphics; Howard Camp for graphics; Jim Culver for sponsoring it; and the NRCS Soil Survey Division for funding it.

Proper citation for this document is:

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D. 1998. Field book for describing and sampling soils. Natural Resources Conservation Service, USDA, National Soil Survey Center, Lincoln, NE.

Cover Photo: Soil profile of a Segno fine sandy loam (*Plinthic Paleudalf*) showing reticulate masses or blocks of plinthite at 30 inches (profile tape is in inches). *Courtesy of Frankie F. Wheeler, NRCS, Temple TX; and Larry Ratliff (retired), National Soil Survey Center, Lincoln, NE.*

FOREWORD

Purpose: The following instructions, definitions, concepts, and codes are a field guide for making or reading soil descriptions and sampling soils as presently practiced in the USA.

Background: This document is an expanded and updated version of earlier guides and short-hand notation released by the Soil Conservation Service (e.g., Spartanburg, SC, 1961; Western Technical Center, Portland, OR, 1974). The knowledge base in those releases was developed by soil scientists during the formative years of the Soil Survey Program. Roy Simonson and others summarized this information in the 1950s (e.g., Soil Survey Staff, 1951; Soil Survey Staff, 1962). This document summarizes our present knowledge base.

Standards: This book summarizes the current National Cooperative Soil Survey conventions for describing soils. Where the content deviates from the initial sources (SSM, 1993; NSSH, 1996; PDP 3.6, 1996; etc.), excepting errors, this document updates them.

Regarding PEDON (PDP 3.5 / 3.6): This document is intended to be both current and useable by the entire soil science community; it is not a guide on "How to use PDP". At this time, PDP is the most dated and therefore the least compatible NRCS document relative to the Soil Survey Manual, National Soil Survey Handbook, Keys to Soil Taxonomy, and NASIS. Differences and linkages between PDP 3.6 and NASIS are shown, where reasonable to do so as an aid to conversions. Future releases of this book are unlikely to include PDP materials.

Standard procedures and terms for describing soils have changed and increased in recent years (e.g., redoximorphic features). Coincident with these changes has been the development and use of computer databases to store soil descriptions and information. The nature of databases, for better or worse, requires consistent and "correct" use of terms.

Sources: This Field Book draws from several primary sources: The Soil Survey Manual (Soil Survey Staff, 1993); the PEDON Description Program (PDP) Version 4 Design Documents (Soil Survey Staff, 1996d); and the National Soil Survey Handbook (NSSH) -- Parts 618 and 629 (Soil Survey Staff, 1996c). Other less pervasive sources are footnoted throughout the Field Book to encourage access to original information.

Brevity: In a field book, brevity is efficiency. Despite this book's apparent length, the criteria, definitions, and concepts presented here are condensed. We urge users to review the more comprehensive information in the original sources to avoid errors due to our brevity.

Units: It is critical to specify and consistently use units for describing a soil. Metric units are preferred. NASIS requires metric units. (In PDP, you can choose Metric or English units.)

Format: The "Site Description Section" and "Profile Description Section" in this book generally follow conventional profile description format and sequence (e.g., SCS-232, December 1984). Some data elements (descriptors) are rearranged in this document into a sequence that is more compatible with the description process in the field (e.g., **Horizon Boundary** is next to **Horizon Depth**, rather than at the very end). This sequence is somewhat different from and does <u>not</u> supersede the conventions followed in writing formal soil descriptions for Soil Survey Reports or Official Soil Series Descriptions (i.e., National Soil Survey Handbook, Part 614, p. 13-22; Soil Survey Staff, 1996).

Codes: Short-hand notation is listed in the *Code* column for each descriptor. Long-standing, conventional codes are retained because of their widespread recognition. Some codes of recent origin have been changed to make them more logical. Some data elements have different codes in various systems [e.g., conventional (Conv.) vs. NASIS vs. PEDON Description Program codes (PDP)] and several columns may be shown to facilitate conversions. The preferred, standard code is shown **bold**. If only 1 untitled code column is shown, it can be assumed that the conventional, NASIS, and PDP codes are all the same.

Standard Terms vs. Creativity: <u>Describe and record what you observe</u>. Choice lists in this document are a minimal set of descriptors. Use additional descriptors, notes, and sketches to record pertinent information and/or features for which no data element exists. Record such information as free-hand notes under **Miscellaneous Field Notes** (or **User Defined Entries** in PDP).

Changes: Soil Science is an evolving field. Changes to this Field Book should and will occur. Please send comments or suggestions to the authors at the National Soil Survey Center, USDA-NRCS; 100 Centennial Mall North, Rm. 152; Lincoln, NE 68508-3866.

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SITE DESCRIPTION

Compiled by: P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, NRCS, Lincoln, NE; W. D. Broderson, NRCS, Salt Lake City, UT.

DESCRIBER(S) NAME

NAME (or initials) - Record the observer(s) who make the description; e.g., *Erling E. Gamble* or *EEG*.

DATE

MONTH / DAY / YEAR - Record the date of the observations. Use two digits for each; e.g., *05/21/96* (for May 21, 1996).

CLIMATE

Document the prevailing, general weather conditions at the time of observation. (Not a data element in PDP; a site-condition which affects some field methods; e.g., K_{sat}). Record the dominant **Weather Conditions** and **Air Temperature**; e.g., *Rain, 27°C*.

Weather Conditions	Code
Sunny / Clear	SU
Partly Cloudy	PC
Overcast	OV
Rain	RA
Sleet	SL
Snow	SN

AIR TEMPERATURE - The ambient air temperature at approximately chest height (in degrees, Celsius or Fahrenheit); e.g., *27°C*.

SOIL TEMPERATURE - Record the ambient **Soil Temperature** and the **Depth** at which it is determined; e.g., *22°C, 50 cm*. (***NOTE***: Soil Taxonomy generally requires a depth of 50 cm.) Soil temperature should only be determined from a freshly excavated surface that reflects the ambient soil conditions. Avoid surfaces equilibrated with air temperatures.

Soil Temperature - Record the soil temperature (in °C or °F).

Soil Temperature Depth - Record the depth at which the ambient soil temperature is measured; e.g., *50 cm*.

LOCATION

Record the geographical location of the point / area of interest as precisely as possible.

LATITUDE - e.g., *46° 10' 19.38" N. Lat.*

LONGITUDE - e.g., *95° 23' 47.16" W. Long.*

NOTE: Latitude and Longitude are required in NASIS. For other location descriptors (e.g., *Public Land Survey*, *UTM*, *Metes and Bounds*, *State Plane Coordinates*, etc.), see the “Location Section”.

TOPOGRAPHIC QUADRANGLE

Record the appropriate topographic map name (i.e., Quadrangle Name) covering the observation site (commonly a USGS topographic map). Include the scale (or map “series”) and the year printed; e.g.,
Pollard Creek - NW; TX; 1:24,000; 1972.

SOIL SURVEY AREA IDENTIFICATION NUMBER (SSID)

An identification number must be assigned if samples are collected for analyses at the National Soil Survey Laboratory. This identifier consists of four required and one optional part. These are:

1) The letter *S* (for “soil characterization sample”) and the two-digit calendar year; e.g., *S96* (for 1996).
2) The two-character state abbreviation; e.g., *OK* (for Oklahoma). For non-USA samples, use the abbreviation *FN*.
3) The three-digit county FIPS code; e.g., *061* (for Haskell County, OK). For non-USA samples, use the appropriate three-digit GSA world-wide geographical location code (Public Building Service, 1996).
4) A three-digit, sequential code to identify the individual pedons sampled within the county or other survey area during any given calendar year; e.g., *005*. (***NOTE***: This sequential code starts over with *001* each January 1.)

5) (Optional) A one-character sub-sample code. This is generally used to indicate some relationship (such as satellite samples) between sampling sites; e.g., *A*.

A complete example is *S96OK061005A*. [Translation: A pedon sampled for soil characterization during 1996 (*S96*), from Oklahoma (*OK*), in Haskell County (*061*), it's the fifth pedon (*005*) sampled in that county during 1996, and it's a satellite sample (*A*) related to the primary pedon.]

COUNTY FIPS CODE

This is the three-digit FIPS code for the county (National Institute of Standards and Technology, 1990) in a U.S. state in which the pedon or site is located. It is usually an odd number; e.g., *061* (for Haskell County, OK). For non-USA samples, enter *FN* followed by the appropriate three-digit GSA world-wide geographical location code (Public Building Service, 1996); e.g., *FN260* (for Canada).

MLRA

This is the one- to three-digit (and one-character sub-unit, if applicable) Major Land Resource Area identifier (SCS, 1981); e.g., *58C* (for Northern Rolling High Plains - Northeastern Part).

TRANSECTS

TRANSECT ID - This is a four- to five-digit number that identifies the transect; e.g., *0029* (the 29th transect within the survey area).

STOP NUMBER - If the sample/pedon is part of a transect, enter the two-digit stop number along the transect; e.g., *07*. (***NOTE***: NASIS allows up to 13 characters).

INTERVAL - Record distances between observation points, compass bearings, and GPS coordinates; or draw a route map in the **Field Notes** ("User Defined Section"). In PDP, if the observation is part of a transect, enter the distance (in feet or meters) between points; e.g., *30 m*.

SERIES NAME

This is the assumed Soil Series name at the time of the description; e.g., *Cecil*. (If unknown, enter *SND* for "Series Not Designated"). (***NOTE***: The field-assigned series name may ultimately change after additional data collection and lab analyses.)

GEOMORPHIC INFORMATION

See the "Geomorphology Section" for complete choice lists. Codes are shown following each example. Conventional "codes" traditionally consist of the entire name; e.g., *mountains*.

PART 1: PHYSIOGRAPHIC LOCATION

Physiographic Division - e.g., *Interior Plains* or *IN*
Physiographic Province - e.g., *Central Lowland* or *CL*
Physiographic Section - e.g., *Wisconsin Driftless Section* or *WDS*
State Physiographic Area (Opt.) - e.g., *Wisconsin Dells*
Local Physiographic/Geographic Name (Opt.) - e.g., *Bob's Ridge*

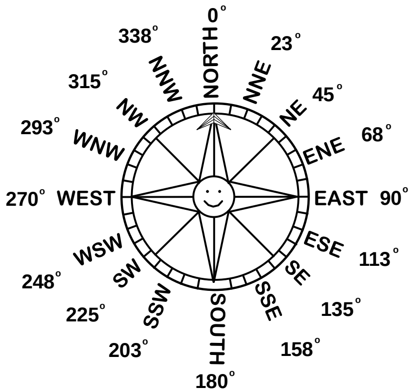
PART 2: GEOMORPHIC DESCRIPTION

Landscape - e.g., *Foothills* or *FH*
Landform - e.g., *Ridge* or *RI*
Microfeature - e.g., *Mound* or *M*
Anthropogenic Feature - e.g., *Hidden* or *H*

PART 3: SURFACE MORPHOMETRY

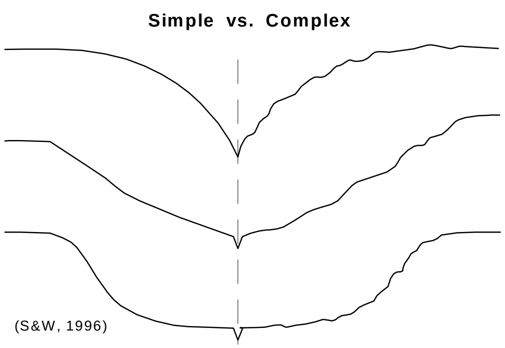
Elevation - The height of a point on the earth's surface, relative to mean sea level (MSL). Use specific units; e.g., *106 m* or *348 ft*. Recommended methods: Interpolation from topographic map contours; altimeter reading tied to a known datum. ***NOTE***: At present, elevational determination by a sole Global Positioning System (GPS) unit is considered unacceptably inaccurate.

Slope Aspect - The compass direction (in degrees and accounting for declination) that a slope faces, looking downslope; e.g., *287°*.

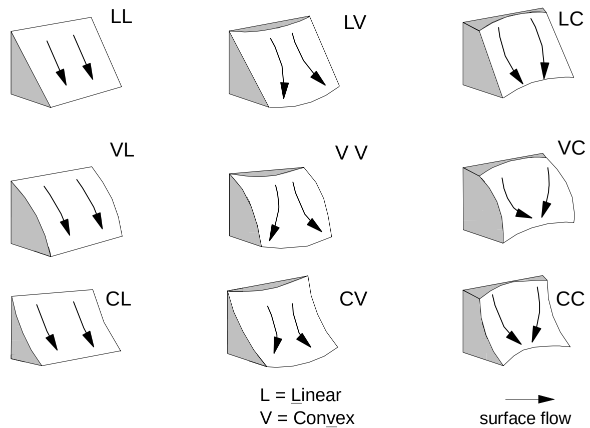


Slope Gradient - The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. Commonly called "slope". Make observations facing downslope to avoid errors associated with some brands of clinometers; e.g., *18%*.

Slope Complexity - Describe the relative uniformity (smooth linear or curvilinear = *simple* or *S*) or irregularity (*complex* or *C*) of the ground surface leading downslope through the point of interest; e.g., s*imple* or *S*.



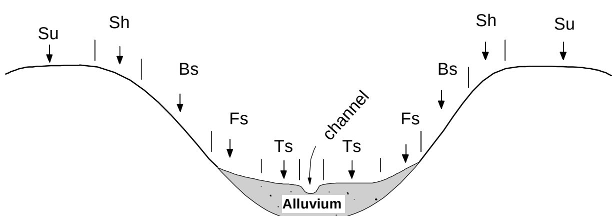
Slope Shape - Slope shape is described in two directions: up-and-down slope (perpendicular to the contour), and across slope (along the horizontal contour); e.g., *Linear, Convex* or *LV*.



(S&W, 1996)

Hillslope - Profile Position (Hillslope Position in PDP) - Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

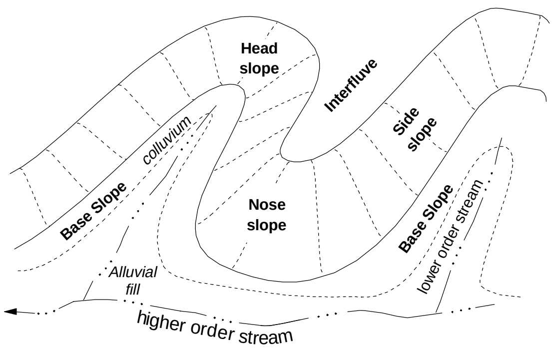
Position	Code
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS



(PJS, 1996; adapted from Ruhe, 1975)

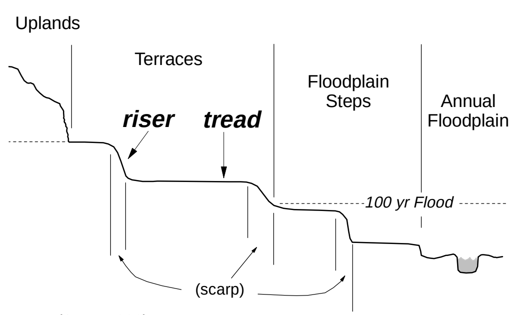
Geomorphic Component - Three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for Hills, Terraces, Mountains, and Flat Plains; e.g., (for Hills) *nose slope* or *NS.*

Hills	Code	
	PDP	NASIS
interfluve	IF	IF
head slope	HS	HS
nose slope	NS	NS
side slope	SS	SS
base slope	---	BS



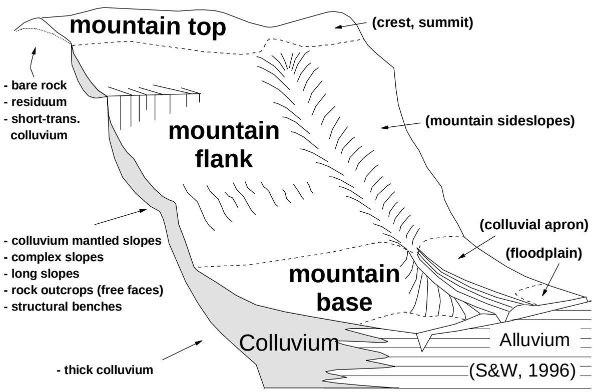
(PJS, 1996; adapted from Ruhe, 1975)

Terraces	Code
riser	RI
tread	TR



(S&W, 1996)

Mountains	Code
mountaintop	MT
mountainflank	MF
upper third	--
mid third	--
lower third	--
mountainbase	MB



Flat Plains (*proposed*)	Code

Microrelief - Small, relative differences in elevation between adjacent areas on the earth's surface; e.g., *micro-high* or *MH*; or *micro-low* or *ML*.

DRAINAGE - An estimate of the natural drainage class (i.e., the prevailing wetness conditions) of a soil; e.g., *somewhat poorly drained* or *SP*.

Drainage Class	Code	
	PDP	**NASIS**
Very Poorly Drained	VP	VP
Poorly Drained	P	PD
Somewhat Poorly Drained	SP	SP
Moderately Well Drained	MW	MW
Well Drained	W	WD
Somewhat Excessively Drained	SE	SE
Excessively Drained	E	ED

The following definitions are the traditional, national criteria for Natural Soil Drainage Classes (Soil Survey Staff, 1993). More specific, <u>regional definitions and criteria vary</u>. (Contact an NRCS State Office for specific, local criteria).

Very Poorly Drained - Water is at or near the soil surface during much of the growing season. Internal free-water is *shallow* and *persistent* or *permanent*. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Commonly, the soil occupies a depression or is level. If rainfall is persistent or high, the soil can be sloping.

Poorly Drained - The soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Internal free-water is *shallow* or *very shallow* and *common* or *persistent*. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soil, however, is not continuously wet directly below plow depth. The water table is commonly the result of *low* or *very low* saturated hydraulic conductivity class or persistent rainfall, or a combination of both factors.

Somewhat Poorly Drained - The soil is wet at a shallow depth for significant periods during the growing season. Internal free-water is commonly *shallow* to *moderately deep* and *transitory* to *permanent*. Unless the soil is arificially drained, the growth of most mesophytic plants is markedly restricted. The soil commonly has a *low* or *very low* saturated hydraulic conductivity class, or a high water table, or receives water from lateral flow, or persistent rainfall, or some combination of these factors.

Moderately Well Drained - Water moves through the soil slowly during some periods of the year. Internal free water commonly is *moderately deep* and may be *transitory* or *permanent*. The soil is wet for only a short time within the rooting depth during the growing season. The soil commonly has a *moderately low*, or lower, saturated hydraulic conductivity class within 1 meter of the surface, or periodically receives high rainfall, or both.

Well Drained - Water moves through the soil readily, but not rapidly. Internal free-water commonly is *deep* or *very deep*; annual duration is not specified. Water is available to plants in humid regions during much of the growing season. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soil is deep to, or lacks redoximorphic features.

Somewhat Excessively Drained - Water moves through the soil rapidly. Internal free water commonly is *very rare* or *very deep*. The soils are commonly coarse-textured, have high saturated hydraulic conductivity, and lack redoximorphic features.

Excessively Drained - Water moves through the soil very rapidly. Internal free water commonly is *very rare* or *very deep*. The soils are commonly coarse-textured, have very high saturated hydraulic conductivity, and lack redoximorphic features.

FLOODING - Estimate the **Frequency**, **Duration**, and the **Months** flooding is expected; e.g., *rare, brief, Jan. - March*.

Frequency -

Frequency Class	**Code** PDP	**NASIS**	**Criteria: estimated, average number of flood events per time span** [1]
None	NO [2]	NO	No reasonable chance (e.g., < 1 time in 500 years)
Very Rare	---	VR	≥ 1 time in 500 years, but < 1 time in 100 years
Rare	RA	RA	1 to 5 times in 100 years
Occasional [3]	OC	OC	> 5 to 50 times in 100 years
Frequent [3, 4]	FR	FR	> 50 times in 100 years
Very Frequent [4]	---	VF	> 50% of all months in year [2]

[1] Flooding Frequency is an estimate of the natural, unmanaged conditions (ignore influence by dams, levees, etc.).
[2] In PDP, *None* class (< 1 time in 100 years) spans both *None* and *Very Rare* NASIS classes.

[3] Historically, *Occasional* and *Frequent* classes could be combined and called *Common*; not recommended.
[4] *Very Frequent* class takes precedence over *Frequent*, if applicable.

Duration -

Duration Class	Code	Criteria: estimated, average duration per flood event
Extremely Brief	EB	0.1 to < 4 hours
Very Brief	VB	4 to < 48 hours
Brief	BR	2 to < 7 days
Long	LO	7 to < 30 days
Very Long	VL	≥ 30 days

Months - Estimate the begining and ending month(s) of the year that flooding generally occurs; e.g., *Dec. - Feb*.

PONDING - Estimate or monitor the **Frequency**, **Depth**, and **Duration** of standing water. In PDP, also note the months ponding generally occurs. A complete example is: *occasional, 50 cm, brief, Feb - Apr*.

Frequency -

Frequency Class	Code	Criteria: estimated average # of ponding events per time span
None	NO	< 1 time in 100 years
Rare	RA	1 to 5 times in 100 years
Occasional	OC	> 5 to 50 times in 100 years
Frequent	FR	> 50 times in 100 years

Depth - Estimate the average, representative depth of ponded water at the observation site and specify units; e.g., *1 ft*, or *30 cm*.

Duration -

Duration Class	Code	Criteria: estimated average time per ponding event
Very Brief	VB	< 2 days
Brief	BR	2 to < 7 days
Long	LO	7 to < 30 days
Very Long	VL	≥ 30 days

(SOIL) WATER STATE - (In NASIS and PDP this data element is called **Soil Moisture Status**.) Estimate the water state of the soil at the time of observation; e.g., *wet, satiated*. Soil temperature must be above 0°C. To record conditions with temperatures < 0°C (frozen water); for permanently frozen conditions, see **Texture Modifiers** or **Terms Used in Lieu of Texture** in the "Profile Description Section". ***NOTE***: Criteria have changed.

Water State Class	Code	Criteria: tension	Traditional Criteria: tension and field
Dry [1]	D	> 1500 kPa	> 15 bars of tension [3]
Moist [1]	M	≤ 1500 to > 1 or > 0.5 kPa [2]	Former Usage: > 1/3 to 15 bars of tension (field capacity to wilting point)
Wet	W	< 1.0 or < 0.5 kPa [2]	0 - 1/3 bars tension (field capacity or wetter)
Wet, Non-satiated [4]	WN	> 0.01 and < 1.0 kPa or < 0.5 kPa [2] No Free Water	Water films are visible; sand grains and peds glisten, but no free water is present
Wet, Satiated [4]	WS	< 0.01 kPa, Free Water	Free water easily visible

[1] Additional subclasses of water state can be recognized for *Dry* and *Moist* classes, if desired (Soil Survey Staff, 1993; p. 91).

[2] Use the 1 kPa limit for all textures, except those coarser than loamy fine sand (Soil Survey Staff, 1993; p. 90).

[3] Convention assumes 15 bars of tension as the wilting point for most annual, agricultural row-crops. Caution: Various perennials, shrubs, trees, and other native vegetation have wilting points up to 66 bars tension (= 6600 kPa) or more.

[4] Satiation vs. Saturation: Satiation implies minor amounts of entrapped air in the smallest pores. True saturation excludes entrapped air. Satiation, for practical purposes, is ≈ saturation. Temporal monitoring of a water table by piezometer or other accepted methods may be needed to verify saturation. Related terms used for classifying soils (i.e., Soil Taxonomy) follow. *Endosaturation* is saturation in all layers to > 200 cm (80 inches). *Episaturation* requires saturated layers that overly unsaturated layers within the upper 2 m (80 inches). *Anthric saturation*, a variant of episaturation, is saturation due to management-induced flooding (e.g., for rice or cranberry production).

DEPTH TO WATER TABLE - Measure or estimate the depth from the ground surface to the stabilized contact with free-standing water in an open bore-hole or well. Historically, record **Seasonal High Water Table - Kind**, and **Frequency** (duration, beginning month, and days); specify units (e.g., cm, ft). If seasonally variable water is absent at time of observation, it is common practice to estimate prevailing water table conditions based upon soil morphology (e.g., presence of Redoximorphic Features of chroma ≤ 2) in lieu of water-table monitoring data.

> ***NOTE***: Within NRCS's PDP and NASIS databases the traditional designation of **Seasonal High Water Table - Kind** and **Frequency** are replaced. In PDP (PEDON), all water table information is recorded in a temporal table. Record **Depth to Stabilized Free Water** and **Date of Observation**. In NASIS, all water table information is replaced by **(Soil) Water State**, for each layer, and recorded on a monthly basis; e.g., *Jan: layer A is moist, layer B is wet, layer C is dry; Feb: layer A is wet, layer B is wet, layer C is moist*.

(Seasonal) High Water Table - Kind - Traditional types of intermittent (e.g., seasonal) high water tables (Soil Survey Staff, 1983).

Kind	Code		Criteria:
	PDP	**NASIS**	
Apparent	A	AP	Level of stabilized water in a fresh, unlined borehole.
Artesian	---	AR	The final water level within a cased borehole in which the water level rises above an impermeable layer due to a positive hydrostatic head.
Perched	P	PE	A water table that lies above an unsaturated zone. The water table will fall if the borehole is extended.
Ponding [1]	---	---	Standing water in a closed depression on top of the soil.

[1] A kind of intermittent water table, but not a seasonal high water table (Soil Survey Staff, 1983).

VEGETATION / LAND COVER

EARTH COVER - KIND - Record the dominant land cover at the site; e.g., *intermixed hardwoods & conifers*. (Similar to **Landuse** in PDP.)

Kind [1]	Code	Kind [1]	Code
ARTIFICIAL COVER (A) - Nonvegetative cover; due to human activity.			
rural transportation - roads, railroads	ARU	urban and built-up - cities, farmsteads, industry	AUR
BARREN LAND (B) - < 5% vegetative cover naturally or from construction.			
culturally induced - saline seeps, mines, quarries, and oil-waste areas	BCI	other barren - salt flats, mud flats, slickspots, badlands	BOB
permanent snow or ice	BPS	rock	BRK
sand or gravel	BSG		
CROP COVER (C) - includes entire cropping cycle (land prep, crop, or crop residue) for annual or perennial herbaceous plants.			
close-grown crop - wheat, rice, oats, and rye; small grains	CCG	row crop - corn, cotton, soybeans, tomatoes, and other truck crops, tulips	CRC
GRASS / HERBACEOUS (G) - > 50% grass, grass-like (sedge/rushes), or forb cover, mosses, lichens, ferns; non-woody.			
hayland - alfalfa, fescue, bromegrass, timothy	GHL	rangeland, savanna - 10 to 20% tree cover	GRS
marshland - grasses and grass-like plants	GML	rangeland, shrubby - 20 to 50% shrub cover	GRH
pastureland, tame - fescues, bromegrass, timothy, and lespedeza	GPL	rangeland, tundra	GRT
rangeland, grassland; < 10% trees, < 20%shrubs; rangeland used for hayland	GRG	other grass & herbaceous cover	GOH
SHRUB COVER (S) - > 50% shrub or vine canopy cover.			
crop shrubs - filberts, blueberry, ornamental nursery stock	SCS	native shrubs - shrub live oak, mesquite, sage-brush, creosote bush; rangeland > 50% shrub cover	SNS
crop vines - grapes, blackberries, raspberries	SCV	other shrub cover	SOS

TREE COVER (T) - > 25% canopy cover by woody plants, natural or planted.			
conifers - spruce, pine, fir	TCD	swamp - trees, shrubs	TSW
crop, trees - nuts, fruit, nursery, Christmas trees	TCR	tropical - mangrove and royal palms	TTR
hardwoods - oak, hickory, elm, aspen	THW	other tree cover	TOC
intermixed hardwoods & conifers - oak-pine mix	TIM		
WATER (W) - water at the soil surface; includes seasonaly frozen water.			

[1] Land Cover Kinds are presented at two levels of detail: Bolded table subheadings are the "NASIS - Level 1" choices (NSSH, Part 622, p. 8; Soil Survey Staff, 1996c). Individual choices under the subheadings are the "NASIS - Level 2" choices.

PLANT SYMBOL - Record the codes (scientific plant name abbreviations) for the major plant species found at the site (NRCS, 1996); e.g., *ANGE* (Andropogon gerardii or big bluestem). ***NOTE***: This is the primary plant data element in NASIS.

PLANT COMMON NAME - Record the common names of the major plant species found at the site [NRCS, 1996 (electronic file); SCS, 1989 (hard copy)]; e.g., *cottonwood, big bluestem*. This item may be recorded as a secondary data element to augment the **Plant Symbol**. ***CAUTION***: Multiple common names exist for some plants; not all common names for a given plant are in the National Plants database.

PLANT SCIENTIFIC NAME - Record the scientific plant name along with or in lieu of common names; e.g., *Acer rubrum* (Red Maple). [***NOTE***: Although used in the past, scientific names of plants (SCS, 1989) are not presently recorded by the NRCS; e.g., PDP has no data element for and does not recognize scientific plant names.] (***NOTE***: NASIS codes for common plant names are derived from the scientific names.)

PARENT MATERIAL

Record the **Kind(s)** of unconsolidated material (regolith) from which the soil is derived. If the soil is derived directly from the underlying bedrock (e.g., granite), identify the **Parent Material** as either grus, saprolite, or residuum and then record the appropriate **Bedrock - Kind** choice. Multiple parent materials, if present, should be denoted; e.g., *loess, over colluvium, over residuum*. Use numerical prefixs in the **Horizon** designations to denote different parent materials (lithologic discontiniuities); e.g., *A*, *BE*, *2Bt*, *2BC*, *3C*.

KIND - e.g., *saprolite*, *loess*, *colluvium*.

Kind [1]	**Code**		**Kind** [1]	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
EOLIAN DEPOSITS (non-volcanic)					
eolian deposits	E	EOD	loess, calcareous	--	CLO
eolian sands	S	EOS	loess, noncalcareous	--	NLO
loess	W	LOE	parna	--	PAR
GLACIAL DEPOSITS					
glacial drift	D	GDR	till, basal	--	BTI
glaciofluvial deposit	--	GFD	till, flow	--	FTI
glaciolacustrine deposit	--	GLD	till, lodgement	--	LTI
glaciomarine deposit	--	GMD	till, melt-out	--	MTI
outwash	G	OTW	till, slump	--	STI
supraglacial debris-flow	--	SGF	till, supraglacial	--	UTI
till	T	TIL	till, supraglacial melt-out	--	PTI
till, ablation	--	ATI			
IN-PLACE DEPOSITS (non-transported)					
grus [2]	--	GRU	saprolite [2]	--	SAP
residuum [2]	X	RES			
MASS MOVEMENT DEPOSITS [4]					
mass movement deposit	--	MMD	mudflow deposit	--	MFD
block glide deposit	--	BGD	rockfall avalanche dep.	--	RAD
colluvium	V	COL	rockfall deposit	--	RFD
creep deposit	--	CRP	rotational landslide dep.	--	RLD
debris avalanche deposit	--	DAD	scree	--	SCR
debris flow deposit	--	DFD	soil fall deposit	--	SFD
debris slide deposit	--	DSD	talus	--	TAL
earthflow deposit	--	EFD	topple deposit	--	TOD
lateral spread deposit	--	LSD			

MISCELLANEOUS DEPOSITS					
cryoturbate	--	CRY	mine spoil or earthy fill	F	MSE
diamicton	--	DIM			
ORGANIC DEPOSITS [5]					
coprogenic materials	--	COM	organic, grassy materials	--	OGM
diatomaceous earth	--	DIE	organic, herbaceous mat.	--	OHM
marl	--	MAR	organic, mossy materials	--	OMM
organic materials	O	ORM	organic, woody materials	--	OWM
VOLCANIC DEPOSITS (unconsolidated; eolian and mass movement)					
ash *(< 2 mm)*	H	ASH	cinders *(2-64 mm)*	--	CIN
ash, acidic	--	ASA	lahar *(volcaniclastic flow)*	--	LAH
ash, andesitic	--	ASN	lapilli *(2-64 mm, > 2.0 sg* [3]*)*	--	LAP
ash, basaltic	--	ASB	pumice *(< 1.0 sg* [3]*)*	--	PUM
ash, basic	--	ASC	scoria *(> 2.0 sg* [3]*)*	--	SCO
ash flow *(pyroclastic)*	--	ASF	tephra *(all ejecta)*	--	TEP
bombs *(> 64 mm)*	--	BOM			

WATER LAID or TRANSPORTED DEPOSITS					
alluvium	A	ALL	marine deposit	M	MAD
backswamp deposit	--	BSD	overbank deposit	--	OBD
beach sand	--	BES	pedisediment	--	PED
estuarine deposit	Z	ESD	slope alluvium	--	SAL
lacustrine deposit	L	LAD	valley side alluvium	--	VSA

[1] Parent material defintions are found in the “Glossary of Landforms and Geologic Terms”, NSSH - Part 629 (Soil Survey Staff, 1996c), or the “Glossary of Geology” (Bates et al., 1987).

[2] Use the most precise term for the in situ material. Residuum is the most generic term.

[3] sg = specific gravity = the ratio of a material’s density to that of water [weight in air / (weight in air - weight in water)].

[4] Cruden and Varnes, 1996.

[5] These generic terms refer to the dominant, origin of the organic materials or deposits from which the organic soil has formed (i.e. parent material) (Soil Survey Staff, 1993). These terms partially overlap with those recognized in Soil Taxonomy (terms which refer primarily to what the organic material presently is); see the “Diagnostic Horizons Table” or “Properties Table”.

BEDROCK

Describe the nature of the continuous hard rock underlying the soil. Specify the **Kind**, **Fracture Interval**, **Hardness**, and **Weathering Class**.

KIND - e.g., *limestone*.

Kind	Code [1] PDP	Code [1] NASIS	Kind	Code [1] PDP	Code [1] NASIS
IGNEOUS-INTRUSIVE					
diabase	--	DIA	monzonite	--	MON
diorite	--	DIO	peridotite	--	PER
gabbro	--	GAB	pyroxenite	--	PYX
granite	I4	GRA	syenite	--	SYE
granodiorite	--	GRD	syenodiorite	--	SYD
IGNEOUS-EXTRUSIVE					
aa *(lava)*	P8	AAL	pahoehoe *(lava)*	P9	PAH
andesite	I7	AND	pumice *(flow, coherent)*	E6	PUM
basalt	I6	BAS	rhyolite	--	RHY
dacite	--	DAC	scoria *(coherent, mass)*	E7	SCO
latite	--	LAT	trachyte	--	TRA
obsidian	--	OBS			
IGNEOUS-PYROCLASTIC					
ignimbrite	--	IGN	tuff breccia	P7	TBR
pyroclastics *(coherent)*	P0	PYR	volcanic breccia	P4	VBR
tuff	P1	TUF	volcanic breccia, acidic	P5	AVB
tuff, acidic	P2	ATU	volcanic breccia, basic	P6	BVB
tuff, basic	P3	BTU			
METAMORPHIC					
amphibolite	--	AMP	metavolcanics	--	MVO
gneiss	M1	GNE	migmatite	--	MIG
granofels	--	GRF	mylonite	--	MYL
granulite	--	GRL	phyllite	--	PHY
greenstone	--	GRE	schist	M5	SCH
hornfels	--	HOR	serpentinite	M4	SER
marble	L2	MAR	slate	M8	SLA
metaconglomerate	--	MCN	soapstone *(talc)*	--	SPS
metaquartzite	M9	MQT			

SEDIMENTARY-CLASTICS					
arenite	--	ARE	porcellanite	--	POR
argillite	--	ARG	sandstone	A0	SST
arkose	A2	ARK	sandstone, calcareous	A4	CSS
breccia, non-volcanic *(angular fragments)*	--	NBR	shale	H0	SHA
claystone	--	CST	shale, acid	--	ASH
conglomerate *(rounded fragments)*	C0	CON	shale, calcareous	H2	CSH
conglomerate, calcar.	C2	CCN	shale, clayey	H3	YSH
graywacke	--	GRY	siltstone	T0	SIS
mudstone	--	MUD	siltstone, calcareous	T2	CSI
orthoquartzite	--	OQT			
EVAPORITES, ORGANICS, AND PRECIPITATES					
chalk	L1	CHA	limestone, arenaceous	L5	ALS
chert	--	CHE	limestone, argillaceous	L6	RLS
coal	--	COA	limestone, cherty	L7	CLS
dolostone	L3	DOL	limestone, phosphatic	L4	PLS
gypsum	--	GYP	travertine	--	TRA
limestone	L0	LST	tufa	--	TUA
INTERBEDDED					
limestone-sandst.-shale	B1	LSS	sandstone-shale	B5	SSH
limestone-sandstone	B2	LSA	sandstone-siltstone	B6	SSI
limestone-shale	B3	LSH	shale-siltstone	B7	SHS
limestone-siltstone	B4	LSI			

[1] Definitions for bedrock are found in the “Glossary of Landforms and Geologic Terms”, NSSH - Part 629 (Soil Survey Staff, 1996c), and in the “Glossary of Geology” (Bates, et al., 1987).

FRACTURE INTERVAL CLASS -

Average Distance Between Fractures	Code
< 10 cm	1
10 to < 45 cm	2
45 to < 100 cm	3
100 to < 200 cm	4
≥ 200 cm	5

HARDNESS (Obsolete -- used in PDP. NASIS uses **Excation Difficulty** classes and criteria.) -

Hardness Class	Code	Criteria:
Hard	H	Excavation Difficulty is VH or EH [1]
Soft	S	Paralithic contact criteria [2]

[1] *Very Hard (VH)* and *Extremely Hard (EH)* classes from the "Consistence-Excavation Difficulty Table".
[2] See Keys to Soil Taxonomy (Soil Survey Staff, 1996b).

WEATHERING CLASS - The relative extent to which a bedrock has weathered as compared to a presumed, non-weathered state.

Class	Code	Criteria
Slight	SL	Not Available
Moderate	MO	
Strong	ST	

EROSION

Estimate the dominant kind and magnitude of accelerated erosion at the site. Specify the **Kind** and **Degree**.

KIND -

Kind	Code PDP	Code NASIS	Criteria [1]
Wind	I	I	Deflation by wind
Water	W	---	Removal by running water
Sheet	---	S	Even soil loss, no channels
Rill	---	R	Small channels [2]
Gully	---	G	Big channels [3]
Tunnel	---	T	Subsurface voids within soil that enlarge by running water (i.e. piping)

[1] Soil Survey Staff, 1993, p82.
[2] Small, runoff channels that can be obliterated by conventional tillage.
[3] Large, runoff channels that cannot be obliterated by conventional tillage.

DEGREE CLASS -

Class	Code	Criteria: Estimated % loss of the original A & E horizons or, the estimated loss of the upper 20 cm (if original combined A & E horizons were < 20 cm thick). [1]
None	0	0%
1	1	> 0 up to 25%
2	2	25 up to 75%
3	3	75 up to 100%
4	4	> 75% & total removal of A

[1] Soil Survey Staff; 1993, pp 86-89.

RUNOFF

SURFACE RUNOFF - Surface runoff (Hortonian flow, overland flow) is the flow of water from an area that occurs over the surface of the soil. Surface runoff differs from internal flow, or throughflow, that results when infiltrated water moves laterally or vertically within a soil, above the watertable. "The Index (of) Surface Runoff Classes" are relative estimates of surface runoff based on slope gradient and saturated hydraulic conductivity (K_{sat}). This index is specific to the following conditions (Soil Survey Staff, 1993).

- The soil surface is assumed to be bare.
- The soil is free of ice.
- Retention of water by ground-surface irregularities is negligible or low.
- Infiltration is assumed to be at at the steady ponded infiltration stage.
- Water is added to the soil by precipitation or snowmelt that yields 50 mm in 24-hours with no more than 25 mm in any 1-hour period.
- Antecedent soil water state is assumed to be very moist or wet to: a) the base of the solum; b) a depth of 1/2 m; or c) through the horizon that has the minimum K_{sat} within the top 1 meter; whichever is the least depth.

Use the following table and the above conditions to estimate "The Index (of) Surface Runoff Class" for the site. If seasonal or permanent, internal free-water occurs a depth of ≤ 50 cm (very shallow and shallow Internal Free-water classes), use a K_{sat} of *Very Low*. If seasonal or permanent, internal free-water is deeper than 50 cm, use the appropriate K_{sat} from the table. In PDP, if estimating runoff from vegetated areas, define and record under **User Defined Property**.

Index (of) Surface Runoff Classes						
	Saturated Hydraulic Conductivity(Ksat) Class [1]					
	Very High	High	Mod. High	Mod. Low	Low	Very Low
	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - - cm / hour	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - -
Slope Gradient Percent	≥ 36	3.6 to < 36	0.36 to < 3.6	0.036 to < 0.36	0.0036 to < 0.036	< 0.0036
Concave	N	N	N	N	N	N
< 1	N	N	N	L	M	H
1 to < 5	N	VL	L	M	H	VH
5 to < 10	VL	L	M	H	VH	VH
10 to < 20	VL	L	M	H	VH	VH
≥ 20	L	M	H	VH	VH	VH

[1] This table is based on the minimum K_{sat} occurring within 1/2 m of the soil surface. If the minimum K_{sat} for the soil occurs between 1/2 to 1 m, the runoff estimate should be reduced by one class (e.g., *medium* to *low*). If the minimum K_{sat} for the soil occurs below 1 meter, use the lowest K_{sat} class that occurs within 1 m of the surface.

Index (of) Surface Runoff Class Names	Code
Negligible	N
Very Low	VL
Low	L
Medium	M
High	H
Very High	VH

SURFACE FRAGMENTS **(**formerly Surface Stoniness**)**

Record the amount of surface fragment[1] cover (either as a class or as a numerical percent), as determined by either a “point count” or “line-intercept” method. In NASIS, additional details can be recorded: **Surface Fragment Kind**, (use “Rock Fragment - Kind Table”), **Mean Distance Between Fragments** (edge to edge), **Shape** [FL-flat or NF-nonflat], **Size**, **Roundness** (use classes and criteria found in “Rock Fragment - Roundness Table”), and **Rock Fragment - Rupture Resistance**.

Surface Fragment Class [1]	Code Conv [2]	Code NASIS	Criteria: Percentage of surface covered
Stony or Bouldery	1	%	0.01 to < 0.1
Very Stony or Very Bouldery	2	%	0.1 to < 3
Extremely Stony or Ext. Bouldery	3	%	3 to < 15
Rubbly	4	%	15 to < 50
Very Rubbly	5	%	≥ 50

[1] This data element is also used to record large wood fragments (e.g., tree trunks) on organic soils, if the fragments are a management concern and appear to be relatively permanent.

[2] Historically called *Surface Stoniness* classes (now *Surface Fragment* classes). Use as a map-unit phase modifier is restricted to stone-sized fragments, or larger (> 250 mm; Soil Survey Staff, 1953).

DIAGNOSTIC HORIZONS or PROPERTIES

Identify the **Kind** and **Upper** and **Lower Depths** of occurrence of Soil Taxonomic diagnostic horizons and properties; e.g., *mollic epipedon; 0 - 45 cm*. Multiple features per horizon can be recorded. (Called **Feature-Kind** in PDP.)

KIND -

Kind	Code PDP	Code NASIS	Kind	Code PDP	Code NASIS
EPIPEDONS (Diagnostic Surface Horizons)					
Anthropic	A	AN	Mollic	M	MO
Folistic	--	FO	Ochric	O	OC
Histic	H	HI	Plaggen	P	PL
Melanic	ME	ME	Umbric	U	UM
DIAGNOSTIC SUBSURFACE HORIZONS					
Agric	R	AG	Natric	N	NA
Albic	Q	AL	Ortstein	--	OR
Argillic	T	AR	Oxic	X	OX
Calcic	C	CA	Petrocalcic	E	PC
Cambic	B	CM	Petrogypsic	J	PG
Duripan	Z	DU	Placic	K	PL
Fragipan	F	FR	Salic	Y	SA
Glossic	TO	GL	Sombric	I	SO
Gypsic	G	GY	Spodic	S	SP
Kandic	KA	KA	Sulfuric	V	SU

DIAGNOSTIC PROPERTIES - MINERAL SOILS					
Abrupt textural change	AC	AC	Lamella / Lamellae	--	LA
Albic material	--	AM	Lithic contact	L	LC
Albic material, interfinger	IF	AI	Paralithic contact	W	PC
Andic soil properties	AN	AP	Paralithic material	--	PM
Aquic conditions	---	AC	Permafrost	PF	PF
Carbonates, secondary [1]	LI	SC	Petroferric contact	PC	TC
Densic contact	--	DC	Plinthite	PL	PL
Densic material	--	DM	Slickensides	SL	SS
Durinodes	D	DN	Sulfidic material	SU	SM
Fragic soil properties	--	FP			
DIAGNOSTIC PROPERTIES - ORGANIC SOILS					
Fibric soil materials	FI	FM	Limnic materials	LM	LM
Hemic soil materials	HE	HM	Coprogenous earth	CO	CO
Humilluvic materials	HU	UM	Diatomaceous earth	DI	DI
Sapric soil materials	SA	RM	Marl	MA	MA

[1] Secondary carbonates, replaces "soft, powdery lime". ***NOTE***: Gilgai (GI in PDP) is no longer a diagnostic feature in Soil Taxonomy.

DEPTH - Document the zone of occurrence for a diagnostic horizon or property, as observed, by recording the upper and lower depth and specify units; e.g., *22 - 39 cm*. Record **Top Depth** and **Bottom Depth**.

REFERENCES

References for this "Site Description Section" are combined with those at the end of the "Profile / Pedon Description Section".

PROFILE / PEDON DESCRIPTION

Compiled by: D.A. Wysocki, P.J. Schoeneberger, E.C. Benham, NRCS, Lincoln, NE; W. D. Broderson, NRCS, Salt Lake City, UT.

OBSERVATION METHOD

For each layer, indicate the type and relative extent of the exposure upon which the primary observations are made. (Examples of common sampling devices are included in the "Field Sampling Section".) Describe **Kind** and **Relative Size**.

KIND -

Kind	Code	Criteria: Types (common size or ranges)
"Disturbed" Samples		
bucket auger	BA	e.g., open, closed, sand, mud buckets (5-12 cm diam.)
screw auger	SA	e.g., external thread hand augers, power (flight) auger (2-30 cm diam.)
"Undisturbed" Samples		
push tube	PT	e.g., hand held, hydraulic, hollow stem (2-10 cm diam.)
shovel "slice" [1]	SS	e.g., undisturbed block extracted with a shovel (sharpshooter: 20 x 40 cm)
WALL / FLOOR - "Undisturbed" Area or Exposure		
small pit	SP	e.g., hand dug (< 1 m x 2 m)
trench	TR	e.g., backhoe, pipeline (> 1 m x 2 m)
beveled cut	BC	e.g., roadcuts graded to < 60% slope
cut	CU	e.g., roadcut, streambank, medium-sized borrow pit wall > 60% slope (e.g., > 4 m, < 33 m)
large open pit or quarry	LP	large borrow pits, large or irregular banks (e.g., > 33 m)

[1] Field method used for hydric soil investigations.

RELATIVE SIZE - Record the approximate size of the exposure observed. Use cm for "Drill Cores" and m for "Wall/Floor" observations; e.g., *bucket auger, 3 cm*; *trench wall, 3 m*. (***NOTE***: Common size range for each method is indicated in the "Criteria" column of the "Observation Method - Kind Table". These dimensions are not intended to be restrictive or precise; merely approximate.)

HORIZON NOMENCLATURE

Use capital letters to identify master horizons; e.g., *A*, *B*. Use suffixes (lowercase letters) to denote additional horizon characteristics or features; e.g., *Ap*, *Btk*. [For more detailed criteria, see the "Soil Taxonomy Section"; for complete definitions see Keys to Soil Taxonomy (Soil Survey Staff, 1996).] Label a horizon only after all morphology is recorded.

MASTER, TRANSITIONAL AND COMMON HORIZON COMBINATIONS [1] **-**

Horizon	Criteria
O	Predominantly organic matter (litter & humus)
A	Mineral, organic matter (humus) accumulation, loss of Fe, Al, clay
AB (or **EB**)	Dominantly A (or E) characteristics but also contains some characteristics of the B horizon
A/B (or **E/B**)	Discrete, intermingled bodies of A (or E) and B material; majority of horizon is A (or E)
AC	Dominantly A horizon characteristics but also contains characteristics of C horizon
E	Mineral, loss of Si, Fe, Al, clay, or organic matter
E and **Bt**	Thin lamellae within a dominantly E horizon
BA (or **BE**)	Dominantly B characteristics but also containing some attributes of A (or E) horizon
B/A (or **B/E**)	Discrete, intermingled bodies of B and A (E) material; majority of horizon is B material
B	Subsurface accumulation of clay, Fe, Al, Si, humus, $CaCO_3$, $CaSO_4$; or loss of $CaCO_3$; or accumulation of sesquioxides; or subsurface soil structure
BC	Dominantly B horizon characteristics but also contains characteristics of the C horizon
B/C	Discrete, intermingled bodies of B and C material; majority of horizon is B material
CB	Dominantly C horizon characteristics but also contains characteristics of the B horizon
C/B	Discrete, intermingled bodies of C and B material; majority of horizon is C material
C	Little or no pedogenic alteration, unconsolidated earthy material, soft bedrock

R	Hard, continuous bedrock
W	A layer of liquid water (W) or permanently frozen water (Wf) within the soil (excludes water/ice above soil) [2]

[1] Refer to the "Soil Taxonomy Section" for older horizon nomenclature.
[2] NRCS Soil Classification Staff, 1997; personal communication.

HORIZON SUFFIXES - Historically referred to as "Horizon Subscripts", and more recently as "Subordinate Distinctions"[1]. (Historical codes and conversions are shown in the "Soil Taxonomy Section".)

Horizon Suffix [2]	Criteria
a	Highly decomposed organic matter
b	Buried genetic horizon (not used with C horizons)
c	Concretions or nodules
d	Densic layer (physically root restrictive)
e	Moderately decomposed organic matter
f	Permanently frozen soil or ice (permafrost); continuous, subsurface ice; not seasonal
ff	Permanently frozen soil ("Dry" permafrost); no continuous ice; not seasonal [3]
g	Strong gley
h	Illuvial organic matter accumulation
i	Slightly decomposed organic matter
j	Jarosite accumulation [3]
jj	Evidence of cryoturbation [3]
k	Pedogenic carbonate accumulation
m	Strong cementation (pedogenic, massive)
n	Pedogenic, exchangeable sodium accumulation
o	Residual sesquioxide accumulation (pedogenic)
p	Plow layer or other artificial disturbance
q	Secondary (pedogenic) silica accumulation
r	Weathered or soft bedrock
s	Illuvial sesquioxide accumulation
ss	Slickensides
t	Illuvial accumulation of silicate clay
v	Plinthite

w	Weak color or structure within B (used only with B)
x	Fragipan characteristics
y	Pedogenic accumulation of gypsum
z	Pedogenic accumulation of salt more soluble than gypsum

[1] Keys to Soil Taxonomy, 6th Edition, 1994.
[2] Keys to Soil Taxonomy, 7th Edition, 1996.
[3] NRCS Soil Classification Staff, 1997; personal communication.

OTHER HORIZON MODIFIERS -

Numerical Prefixes (2, 3, etc.) - Used to denote lithologic discontinuities. By convention, 1 is understood but is not shown; e.g., *A*, *E*, *Bt1*, ***2****Bt2*, ***2****BC*, ***3****C1*, ***3****C2*.

Numerical Suffixes - Used to denote subdivisions within a master horizon; e.g., *A****1***, *A****2***, *E*, *Bt****1***, *Bt****2***, *Bt****3***, *Bs****1***, *Bs****2***.

The Prime (') -Used to indicate the second occurrence of an identical horizon descriptor(s) in a profile or pedon; e.g., *A*, ***E***, *Bt*, ***E'*** *Btx*, *C*. The prime does not indicate either buried horizons (which are denoted by a lower case "*b*"; e.g., *Btb*), or lithologic discontinuities (denoted by numerical prefixes). Double and triple primes are used to denote subsequent occurrences of horizon descriptors in a pedon; e.g., *A*, *E*, *Bt*, ***E'***, *Btx*, ***E''***, *Cd*.

DIAGNOSTIC HORIZONS - See the "Diagnostic Horizons Table" or "Properties Table", in the "Site Description Section".

HORIZON DEPTH - Record the depths of both the upper and lower boundary for each horizon; specify units (centimeters preferred); e.g., *15-24 cm*. Begin (zero datum) at the ground surface[1], which is not necessarily the mineral surface. (***NOTE***: Prior to 1993, the zero datum was at the top of the mineral surface, except for thick organic layers such as a peat or muck. Organic horizons were recorded as above and mineral horizons recorded as below, relative to the mineral surface.) Example:

	Zero Datum for the same horizons
At Present:	Oe 0 - 5 cm, A 5 - 15 cm, E 15 - 24 cm
Before 1993:	Oe 5 - 0 cm, A 0 - 10 cm, E 10 - 19 cm

[1] Conventionally, the "soil surface" is considered to be the top boundary of the first layer that can support plant / root growth. This equates to:
a) (for bare mineral soil) the air/fine earth interface;
b) (for vegetated mineral soil) the upper boundary of the first layer that can support root growth;

c) (for organic mantles) the same as b) but excludes freshly fallen plant litter, and includes litter that has compacted and begun to decompose; e.g., Oi horizon;
d) (for submerged soil) the same as b) but refers to the water/soil contact and extends out from shore to the limit of emergent, rooted plants;
e) (for rock mulches; e.g., desert pavement, scree) the same as a) unless the areal percentage of surface rock coverage is greater than 80%, the top of the soil is the mean height of the top of the rocks.

HORIZON THICKNESS - Record the average thickness and range in thickness of horizon; e.g., *15 cm* (*12 - 21 cm*).

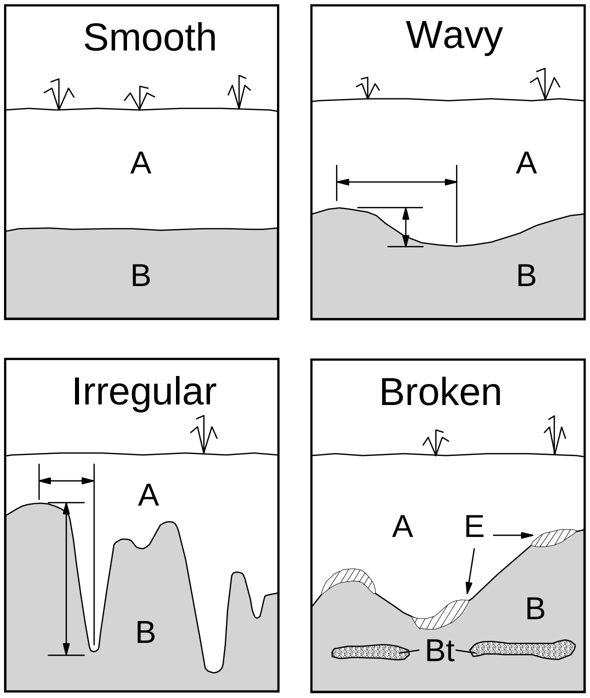
HORIZON BOUNDARY - Record **Distinctness** and **Topography** of horizon boundary. Distinctness is the distance through which one horizon grades into another. Topography is the lateral undulation and continuity of the boundary between horizons. A complete example is: *clear, wavy*, or *C,W*.

Distinctness -

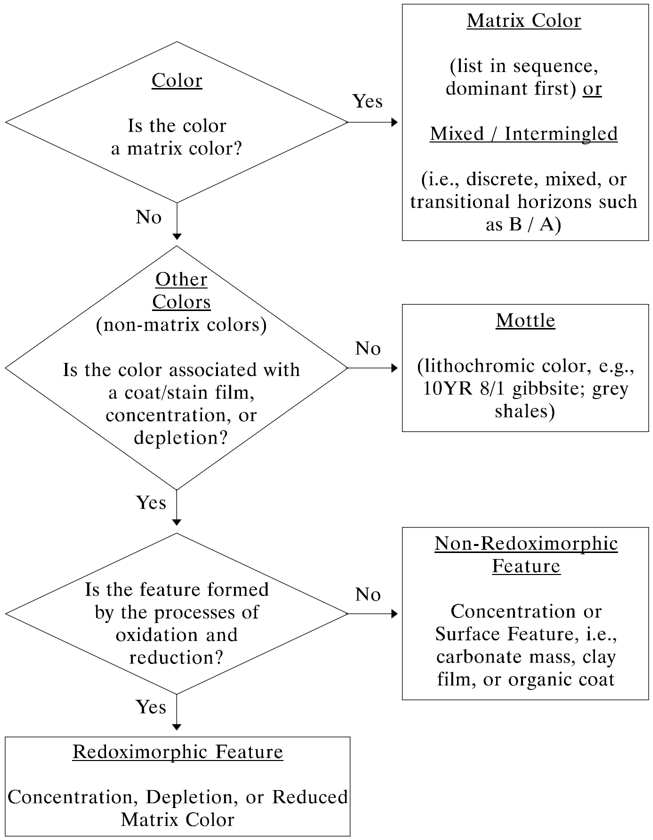
Distinctness Class	**Code** PDP	**NASIS**	**Criteria: thickness**
Very Abrupt	---	V	< 0.5 cm
Abrupt	A	A	0.5 to < 2 cm
Clear	C	C	2 to < 5 cm
Gradual	G	G	5 to < 15 cm
Diffuse	D	D	≥ 15 cm

Topography - Cross-sectional shape of the contact between horizons.

Topography	**Code**	**Criteria**
Smooth	S	Planar with few or no irregularities
Wavy	W	Width of undulation is > than depth
Irregular	I	Depth of undulation is > than width
Broken	B	Discontinuous horizons; discrete but intermingled, or irregular pockets


Smooth
A
B
Wavy
A
B
Irregular
A
B
Broken
A
E
B
Bt

DECISION FLOWCHART FOR DESCRIBING SOIL COLORS - Use the following chart to decide how and with which data elements the color patterns of a soil or soil feature should be described.



NOTE: *Reduced Matrix* color is described as a *Matrix Color* and in the associated “(Soil Color) - Location or Condition Described Table”.

(SOIL) MATRIX COLOR - Record **Color(s)**, **(Soil Color) Moisture State**, **Location or Condition**. (In PDP, also record **Percent of Horizon**, if more than one matrix color is described.)

(Soil) Matrix Color - (Soil) Color - Use Munsell® notation (Hue, Value, Chroma); e.g., *10YR 3/2*. Neutral Gley colors are written as chroma of zero (0); e.g, *N 4/0*. Other gley colors use appropriate notation (see Munsell® Gley pages; e.g., *5GY 6/1*). For narrative descriptions (Soil Survey Reports, Official Series Descriptions) both the verbal name and the Munsell® notation are given; e.g., *dark brown, 10YR 3/3*.

(Soil) Matrix Color - Moisture State - Record the moisture condition of the soil described; e.g., *moist*. (Not to be confused with Soil Water State.)

Moisture State	Code
Dry	D
Moist	M

(Soil) Matrix Color - Location or Condition - Record pertinent circumstances of the color described.

Color Location or Condition	Code PDP	Code NASIS
COLOR LOCATION		
Interior *(within ped)*	1	IN
Exterior *(ped surface)*	2	EX
COLOR, MECHANICAL CONDITION		
Broken Face	8	BF
Crushed	3	CR
Rubbed *(used only with Organic Matter)*	9	RU
COLOR, REDOXIMORPHIC CONDITION		
Oxidized [1]	5	OX
Reduced [2]	---	RE
COLOR, INTRICATE MULTICOLORED PATTERN		
Variegated [3]	---	VA

[1] Soil that is reduced in situ, but oxidizes (changes color) after extraction and exposure to air. A mineral example is vivianite. ***NOTE***: Not used for soil that's normally oxidized in-place. For indicators of reduction see **Redoximorphic Features**.

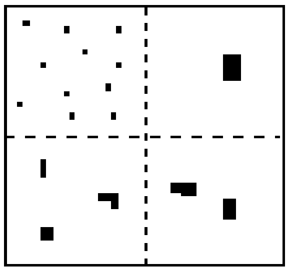
[2] Color immediately after extraction from a reduced environment, prior to oxidation; e.g., *FeS*. Also used to record **Reduced Matrix**.

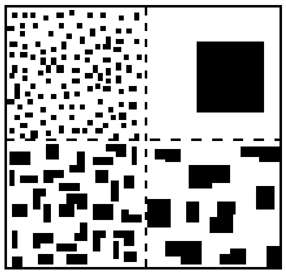
[3] Color pattern is too intricate (banded or patchy) with numerous, diverse colors to credibly identify dominant matrix colors.

MOTTLES - Describe mottles (areas of color that differ from the matrix color). These colors are commonly lithochromic or lithomorphic (attributes retained from the geologic source rather than from pedogenesis; e.g., gray shale). Mottles exclude: Redoximorphic Features (RMF) and Ped & Void Surface Features; e.g., clay films. Record **Quantity Class** (in NASIS/PDP, estimate a numerical value "Percent of Horizon Area Covered"), **Size**, **Contrast**, **Color**, and **Moisture State** (D or M). **Shape** is an optional descriptor (use the "Concentrations - Shape Table"). A complete example is: *few, medium, distinct, reddish yellow moist, irregular mottles* or *f, 2, d, 7.5 YR 7/8, m, z, mottles*.

Mottles - Quantity (Percent of Area Covered) -

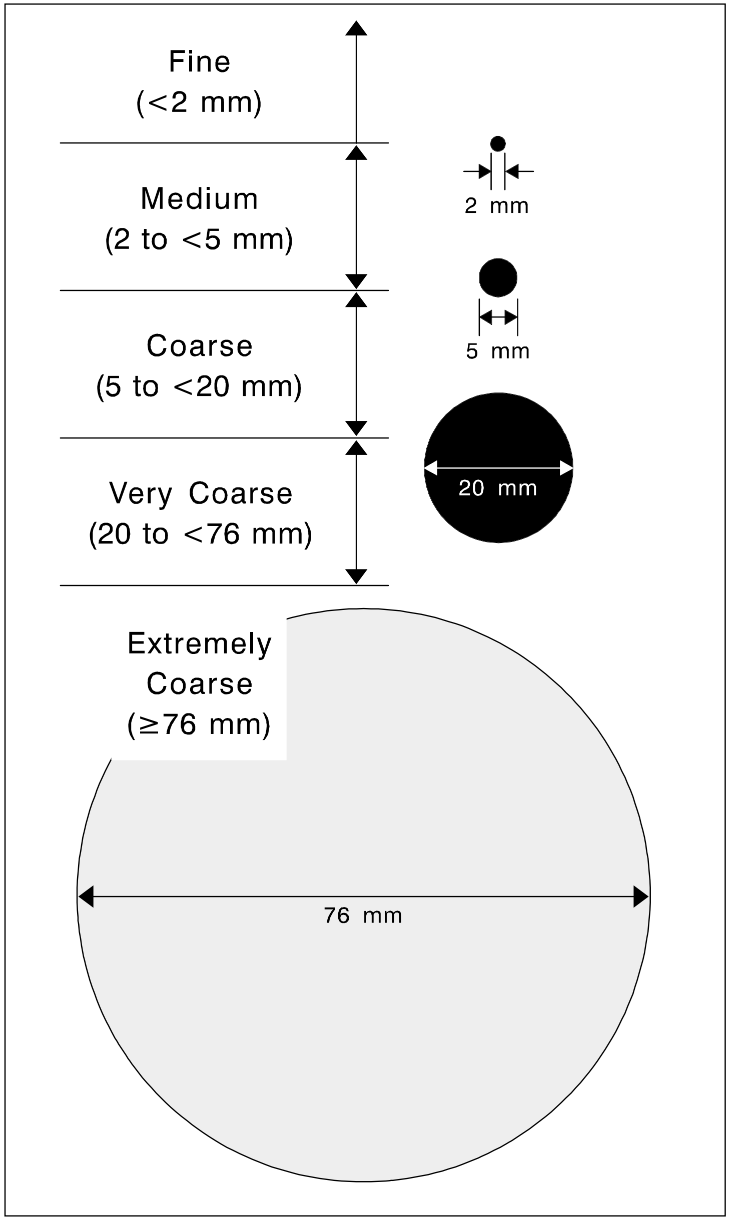
Quantity Class	Code Conv	Code NASIS	Criteria: range in percent
Few	f	%	< 2% of surface area
Common	c	%	2 to < 20% of surface area
Many	m	%	≥ 20% of surface area


2%


20%

Mottles - Size - Record mottle size class. Use length if it's greater than 2 times the width; use width if the length is less than two times the width. Length is the greater of the two dimensions. (New size classes to be consistent with the new RMF size classes.)

Size Class	Code	Criteria
Fine	F	< 2 mm
Medium	M	2 to < 5 mm
Coarse	C	5 to < 20 mm
Very Coarse	VC	20 to < 76 mm
Extremely Coarse	EC	≥ 76 mm


Fine
(<2 mm)
Medium
(2 to <5 mm)
Coarse
(5 to <20 mm)
Very Coarse
(20 to <76 mm)
Extremely
Coarse
(≥76 mm)
2 mm
5 mm
20 mm
76 mm

Mottles - Contrast - Record the color difference between the mottle and the dominant matrix color. Use this table or the following chart to express the difference.

Contrast Class	Code	Difference in Color Between Matrix and Mottle			
		Hue [1]	Value		Chroma
Faint [2]	F	same page	0 to ≤ 2	and	≤ 1
Distinct	D	same page	> 2 to < 4	and	< 4
				<u>or</u>	
			< 4	and	> 1 to < 4
		1 page	≤ 2	and	≤ 1
Prominent	P	same page	≥ 4	or	≥ 4
		1 page	> 2	or	> 1
		≥ 2 pages	≥ 0	or	≥ 0

[1] One Munsell® Color Book page = 2.5 hue units. Table contents compiled from material in or intended by the Soil Survey Manual (Soil Survey Staff, 1993).

[2] *Faint* also includes mottles or RMFs that are similar in color to the matrix that have both low (e.g., ≤ 3) value and chroma, and differ by up to 2.5 units (one page) of hue.

Mottles - Color - Use standard Munsell® notation; e.g., *5 YR 4/4* (for reddish brown).

Mottles - Moisture State - Record the moisture condition of the mottle (not to be confused with soil water state); e.g., *moist*.

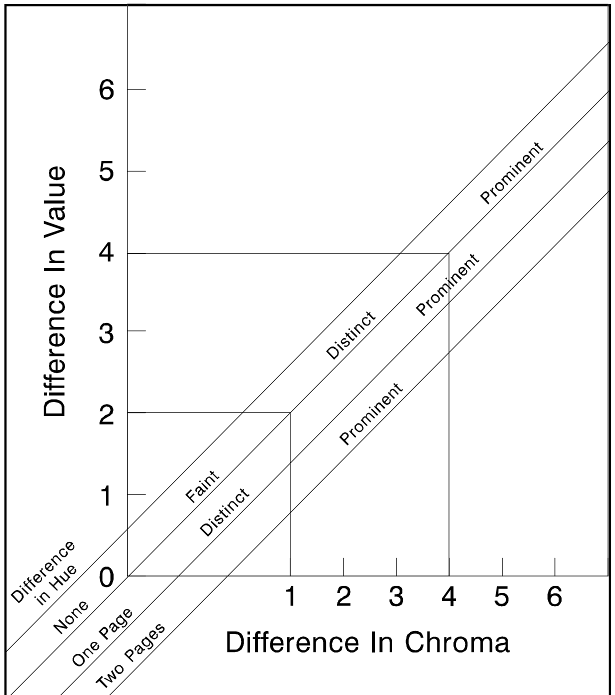
Moisture State	Code
Dry	D
Moist	M

Mottles - Shape (optional) - Use “Concentrations - Shape Table”; e.g., *irregular*.

NOTE: In PDP, **Location (optional)**, and **Hardness (optional)** can be described. Use the choices in the appropriate “Redoximorphic Features Table”.

Contrast of Soil Mottles

(For Use with Munsell Color Book)



If both mottle and matrix have low value or chroma, disregard this chart, and record as Faint (e.g., 10YR 1/1 and 7.5YR 1/1 = faint)

Chart Directions:

A. Select the appropriate "Difference in Hue" line ("None" means "same page").

B. Record greatest contrast of **value** or **chroma** at **hue** line intercept (faint, distinct, or prominent).

REDOXIMORPHIC FEATURES (RMF) DISCUSSION

Redoximorphic Features (RMF) are a color pattern in a soil due to loss (depletion) or gain (concentration) of pigment compared to the matrix color, formed by oxidation / reduction of Fe and/or Mn coupled with their removal, translocation, or accrual; or a soil matrix color controlled by the presence of Fe^{+2}. The composition and process of formation for a soil color or color pattern must be known or inferred before describing it as a RMF. Because of this inference, RMF are described separately from other mottles, concentrations; e.g., *salts*; or compositional features; e.g., *clay films*. RMF generally occur in one or more of these settings:

a. In the soil matrix, unrelated to surfaces of peds or pores.
b. On or beneath the surfaces of peds.
c. As filled pores, linings of pores, or beneath the surfaces of pores.

RMFs include the following:

1. **Redox Concentrations** - Localized zones of enhanced pigmentation due to an accrual of, or a phase change in, the Fe-Mn minerals; or are physical accumulations of Fe-Mn minerals. ***NOTE***: Iron concentrations may be either Fe^{+3} or Fe^{+2}. Types of redox concentrations are:
   a. Masses - Noncemented bodies of enhanced pigmentation that have a redder or blacker color than the adjacent matrix.
   b. Nodules or Concretions - Cemented bodies of Fe-Mn oxides.

2. **Redox Depletions** - Localized zones of “decreased” pigmentation that are grayer, lighter, or less red than the adjacent matrix. Redox depletions include, but are not limited to, what were previously called “low chroma mottles” (chroma $\leq$ 2). Depletions with chroma $\leq$ 2 are used to define aquic conditions in Soil Taxonomy and are used extensively in the field to infer occurrence and depth of saturation in soils. Types of redox depletions are:
   a. Iron Depletions - Localized zones that have one or more of the following: a yellower, greener, or bluer hue; a higher value; or a lower chroma than the matrix color. Color value is normally $\geq$ 4. Loss of pigmentation results from the loss of Fe and/or Mn. Clay content equals that in the matrix.
   b. Clay Depletions - Localized zones that have either a yellower hue, a higher value, or a lower chroma than the matrix color. Color value is normally $\geq$ 4. Loss of pigmentation results from a loss of Fe and/or Mn and clay. Silt coats or skeletans commonly form as depletions but can be non-redox concentrations, if deposited as flow material in pores or along faces of peds.

3. **Reduced Matrix** - A soil horizon that has an in situ matrix chroma ≤ 2 due to the presence of Fe^{+2}. Color of a sample becomes redder or brighter (oxidizes) when exposed to air. The color change usually occurs within 30 minutes. A 0.2% solution of α, α'- dipyridyl dissolved in 1N ammonium acetate (NH_4OAc) pH 7 can verify the presence of Fe^{+2} in the field (Childs, 1981).

NOTE: Use of RMF alters the traditional sequence for describing soil color (see the "Decision Flowchart for Describing Colors for Soil Matrix and Soil Features"). RMF are described separately from other color variations or concentrations. Mottles (color variations not due to loss or accrual of Fe-Mn oxides; e.g., variegated weathered rock) are still described under **Soil Color**. A Reduced Matrix is recorded as a RMF and as "reduced" in **Soil Color - Location** or **Condition Described**.

REDOXIMORPHIC FEATURES

Record **Kind**, **Quantity** (percent of area covered), **Size**, **Contrast**, **Color**, **Moisture State**, **Shape**, **Location**, **Hardness**, and **Boundary**. A complete example is: *common, medium, prominent, black Iron-Manganese nodules, moist, spherical In the matrix, hard, sharp* or *c, 2, p, 5 YR 2.5/1, FNM, M, o, h, s*.

REDOXIMORPHIC FEATURES - KIND -

Kind	**Code** PDP	**NASIS**	**Kind**	**Code** PDP	**NASIS**
REDUCED MATRIX (chroma ≤ 2 primarily from Fe^{+2})					
Reduced Matrix	---	RMX			
REDOX DEPLETIONS (loss of pigment or material)					
Clay Depletions			Iron Depletions		
Chroma ≤ 2	A3	LCD	Chroma ≤ 2	F5	LFD
Chroma > 2	---	HCD	Chroma > 2	---	HFD
REDOX CONCENTRATIONS (accumulated pigment, material)					
Masses [1] *(noncemented)*					
Iron *(Fe^{+3})* [3, 4, 5]	F2	F3M	Iron-Manganese [3, 4, 5]	M2	FMM
Iron *(Fe^{+2})* [2]	---	F2M	Manganese [4, 5]	M8	MNM
Nodules [1] (cemented; no layers, crystals not visible at 10X)					
Ironstone	F4	FSN	Iron-Manganese [4]	M5	FMN
Plinthite	F1	PLN			
Concretions [1] *(cemented; distinct layers, crystals not visible)*					
Iron-Manganese [4]				M3	FMC

Surface Coats / Films or Hypocoats [6]		
Manganese *(mangans: black, very thin, exterior films)*	M [7]	MNF
Ferriargillans *(Fe^{+3} stained clay film)*	I [7]	FEF

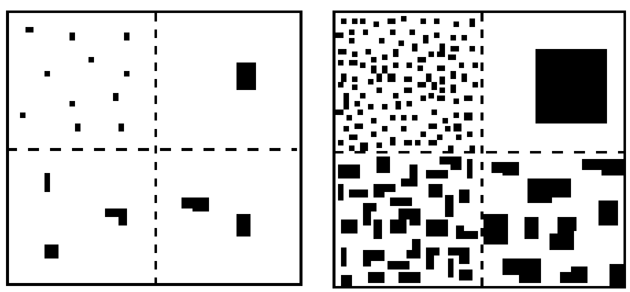
[1] See discussion under **Concentrations** for definitions.
[2] A concentration of reduced iron Fe^{+2}; e.g., *FeS*.
[3] A concentration of oxidized iron Fe^{+3}; e.g., *hematite*, (formerly described as *reddish mottles*).
[4] Iron and Mn commonly occur in combination and field identification of distinct phases is difficult. Use *Mn masses* only for those that are at least *Slightly Effervescent* with H_20_2. Describe nodules and concretions as *Iron-Manganese* unless colors are unambiguous.
[5] Suggested, color guidelines for field description of Fe vs. Mn Masses:

Color of Concentration Value	Chroma	Dominant Composition
≤ 2	≤ 2	Mn
> 2 & ≤ 4	> 2 & ≤ 4	Fe & Mn
> 4	> 4	Fe

[6] See **Ped and Void Surface Feature - Kind**.
[7] In PDP, these features (codes) are recorded under **Coat - Kind**.

REDOXIMORPHIC FEATURES - QUANTITY (Percent of Area Covered) -

Class	**Code** Conv.	NASIS	**Criteria: Percent of Surface Area Covered**
Few	f	#	< 2
Common	c	#	2 to < 20
Many	m	#	≥ 20



2% 20%

REDOXIMORPHIC FEATURES - SIZE - See size class graphic under either **Mottles** or **Concentrations**.

Size Class	Code	Criteria
Fine	1	< 2 mm
Medium	2	2 to < 5 mm
Coarse	3	5 to < 20 mm
Very Coarse	4	20 to < 76 mm
Extremely Coarse	5	≥ 76 mm

REDOXIMORPHIC FEATURES - CONTRAST - Use "Mottle - Contrast Table" or "Mottle - Contrasts Chart"; e.g., *Prominent* or *p*.

REDOXIMORPHIC FEATURES - COLOR - Use standard Munsell® notation from the "Soil Color Section"; e.g., *light brownish gray* or *2.5Y 6/2*.

REDOXIMORPHIC FEATURES - MOISTURE STATE - Describe the moisture condition of the Redoximorphic Feature (use "Soil Color - Moisture State Table"); e.g., *Moist (M)* or *Dry (D)*.

REDOXIMORPHIC FEATURES - SHAPE - Describe the shape of the redoximorphic feature (use "Concentrations - Shape Table"); e.g., *Spherical (O)*.

REDOXIMORPHIC FEATURES - LOCATION - Describe the location(s) of the Redoximorphic Feature within the horizon (use "Concentrations - Location Table"); e.g., *In the matrix (R1)*.

REDOXIMORPHIC FEATURES - HARDNESS - Describe the hardness of the Redoximorphic Feature (use cementation classes from the "Consistence - Rupture Resistance for Blocks / Peds / Clods Table"); e.g., *Extremely Hard (EH)*.

REDOXIMORPHIC FEATURES - BOUNDARY - The gradation between the Redoximorphic Feature and the adjacent matrix (use "Concentrations - Boundary Table"); e.g., *Sharp (S)*.

CONCENTRATIONS DISCUSSION

Concentrations are soil features that form by accumulation of material during pedogenesis. Dominant processes involved are chemical dissolution/ precipitation; oxidation and reduction; and physical and/or biological removal, transport, and accrual. Types of concentrations (modified from Soil Survey Staff, 1993) include the following:

1. **Finely Disseminated Materials** are physically small precipitates (e.g., salts, carbonates) dispersed throughout the matrix of a horizon. The materials cannot be readily seen (10X lens), but can be detected by a chemical reaction (e.g., effervescence of $CaCO_3$ by HCl) or other proxy indicators.

2. **Masses** are noncemented ("Rupture Resistance Cementation Class" of *Extremely Weakly Cemented* or less) bodies of accumulation of various shapes that cannot be removed as discrete units, and do not have a crystal structure that is readily discernible in the field (10X hand lens). This includes finely crystalline salts and Redox Concentrations that do not qualify as nodules or concretions.

3. **Nodules** are cemented (*Very Weakly Cemented* or greater) bodies of various shapes (commonly spherical or tubular) that can be removed as discrete units from soil. Crystal structure is not discernible with a 10X hand lens.

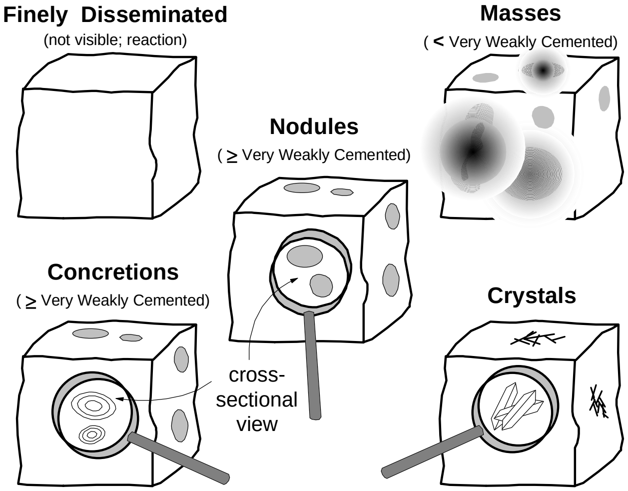
4. **Concretions** are cemented bodies (*Very Weakly Cemented* or greater) similar to nodules, except for the presence of visible, concentric layers of material around a point, line, or plane. The terms "nodule" and "concretion" are not interchangeable.

5. **Crystals** are macro-crystalline forms of relatively soluble salts (e.g., halite, gypsum, carbonates) that form in situ by precipitation from soil solution. The crystalline shape and structure is readily discernible in the field with a 10X hand lens.

6. **Biological Concentrations** are discrete bodies accumulated by a biological process (e.g., fecal pellets), or pseudomorphs of biota or biological processes (e.g., insect casts).

General conventions for documenting various kinds of **Concentrations**:

Type of Distribution	Documentation	Examples
Finely Disseminated (not visible)	Horizon Suffix	Carbonates (Bk) Salts (Bz, Bn)
Masses, Nodules, Concretions, Crystals, Biological Features	Redoximorphic Features, or Concentrations	Mn nodules Fe concretions Insect casts
Continuous Cementation	Terms in Lieu of Texture	Duripan Petrocalcic



CONCENTRATIONS

Record **Kind**, **Quantity** (percent of area covered), **Size**, **Contrast**, **Color**, **Moisture State**, **Shape**, **Location**, **Hardness**, and **Boundary**. A complete example is: *many, fine, prominent, white, moist, cylindrical, carbonate nodules in the matrix, extremely firm, clear* or *m, 1, p, 10YR 8/1, M, c, C4, R1, EF, c*.

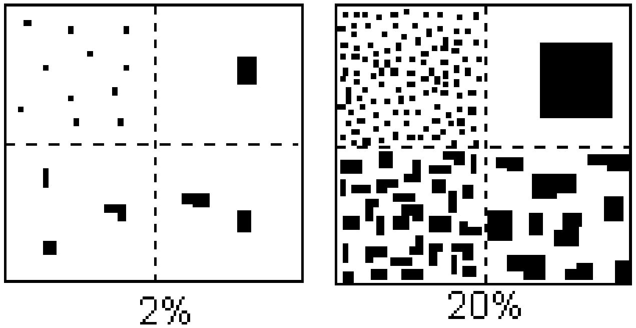
CONCENTRATIONS - KIND - Identify the composition and the physical state of the concentration in the soil. ***NOTE***: Table sub-headings (e.g., *Masses*) are a guide to various physical states of materials. Materials with similar or identical chemical compositions may occur in multiple physical states (under several sub-headings); e.g., *salt masses* and *salt crystals*.

CONCENTRATIONS (NON-REDOX) (accumulations of material)					
Kind	**Code** PDP	**NASIS**	**Kind**	**Code** PDP	**NASIS**
MASSES (noncemented; crystals not visible with 10X hand lens)					
Barite *($BaSO_4$)*	B2	BAM	Gypsum *($CaSO_4 \cdot 2H_20$)*	G2	GYM
Carbonates *($Ca, Mg, NaCO_3$)*	K2	CAM	Salt *(NaCl, Na-Mg Sulfates)*	H2	SAM
Clay Bodies	A2	CBM	Silica	S2	SIM
Gypsum *(Nests)*	G3	GNM			
NODULES (cemented; non-crystalline at 10X, no layers)					
Carbonates [1]	C4	CAN	Gibbsite *(Al_2O_3)*	E4	GBN
Durinodes *(SiO_2)*	S4	DNN	Opal	S1	OPN
CONCRETIONS (cemented; non-crystalline at 10X, distinct layers)					
Carbonates [1]	C3	CAC	Silica	S3	SIC
Gibbsite	E3	GBC	Titanium Oxide	---	TIC
CRYSTALS (crystals visible with 10X hand lens)					
Barite *($BaSO_4$)*	B1	BAX	Gypsum *($CaSO_4 \cdot 2H_20$)*	G1	GYX
Calcite *($CaCO_3$)*	C1	CAX	Salt *(NaCl, Na-Mg Sulfates)*	H1	SAX
BIOLOGICAL CONCENTRATIONS (byproducts or pseudomorphs)					
Fecal Pellets	---	FPB	Shell Fragments *(terrestrial or aquatic)*	---	SFB
Insect Casts [2]	T3	ICB	Sponge Spicules [3]	---	SSB
Plant Phytoliths [3] *(plant opal)*	---	PPB	Worm Casts [2]	T2	WCB
Root Sheaths	---	RSB			

[1] Also known as loess kinchen, loess puppies, etc.
[2] Worm casts are ovoid, fecal pellets excreted by earthworms. Insect casts are cemented (e.g., $CaCO_3$) molds of insect bodies or burrows.
[3] May require magnification > 10X to be observed.

CONCENTRATIONS - QUANTITY (PERCENT OF AREA COVERED) -

Class	Code Conv.	NASIS	Criteria: % of Surface Area Covered
Few	f	#	< 2
Common	c	#	2 to < 20
Many	m	#	≥ 20



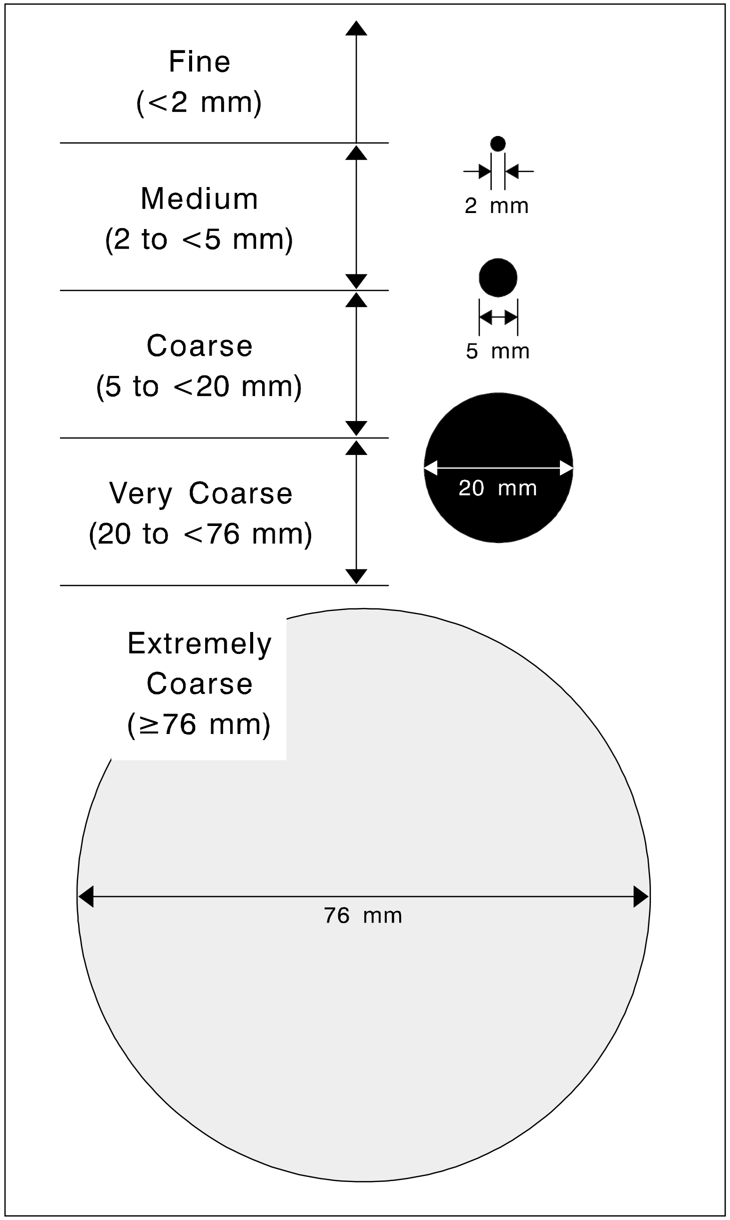
CONCENTRATIONS - SIZE - Use "RMF's" and "Mottle Size Classes". (See graphic on next page.)

Size Class	Code	Criteria
Fine	1	< 2 mm
Medium	2	2 to < 5 mm
Coarse	3	5 to < 20 mm
Very Coarse	4	20 to < 76 mm
Extremely Coarse	5	≥ 76 mm

CONCENTRATIONS - CONTRAST - Use "Mottle - Contrast Table" or "Mottle - Contrast Chart"; e.g., *distinct*.

CONCENTRATIONS - COLOR - Use standard Munsell® notation; e.g., *7.5 YR 8/1*.

CONCENTRATIONS - MOISTURE STATE - Use "Soil Color - Moisture State Table"; e.g., *Moist (M)* or *Dry (D)*.

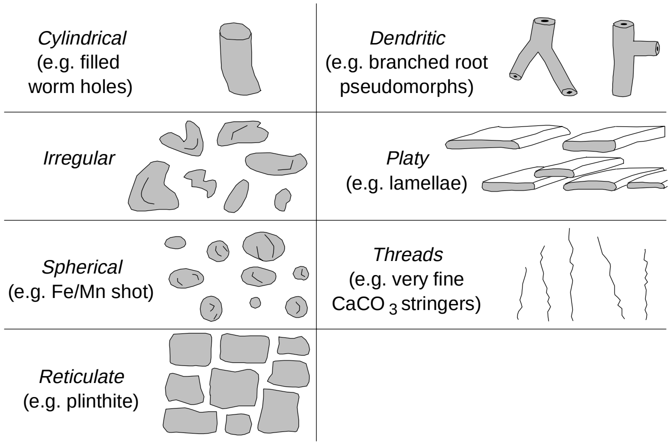

Fine
(<2 mm)
Medium
(2 to <5 mm)
Coarse
(5 to <20 mm)
Very Coarse
(20 to <76 mm)
Extremely
Coarse
(≥76 mm)
2 mm
5 mm
20 mm
76 mm

CONCENTRATIONS - SHAPE -

Shape	Code PDP	Code NASIS	Criteria
Cylindrical	C	C	tubular & elongated bodies; e.g., filled worm holes and insect burrows
Dendritic	D	D	tubular, elongated, branched bodies; e.g., pipestems (root pseudomorphs)
Irregular	Z	I	bodies of non-repeating spacing or shape
Platy	P	P	relatively thin, tabular sheets, lenses; e.g., lamellae
Reticulate	---	R	crudely interlocking bodies with similar spacing; e.g., plinthite
Spherical [1]	O	S	well-rounded to crudely spherical bodies; e.g., Fe / Mn "shot"
Threads	T	T	thin (e.g., < 1 mm diam.) elongated filaments; generally not dendritic; e.g., very fine $CaCO_3$ stringers

[1] Called *Rounded* in PDP.

Examples of Mottles, Concentrations, and RMF Shapes



CONCENTRATIONS - LOCATION - (Also used for **Redoximorphic Features**.) Describe the location(s) of the concentration (or depletion for RMF's) within the horizon. Historically called **Concentrations - Distribution**.

Location	Code	
	PDP	**NASIS**
MATRIX (in soil matrix; not associated with, peds or pores)		
In the matrix *(not associated with peds/pores)*	---	MAT
In matrix around depletions	---	MAD
In matrix around concentrations	---	MAC
Throughout *(e.g., finely disseminated carbonates)*	T	TOT
PEDS (on or associated with faces of peds)		
Between peds	P	BPF
Infused into the matrix along faces of peds *(hypocoats)* [1]	---	MPF
On faces of peds *(all orientations)*	---	APF
On horizontal faces of peds	---	HPF
On vertical faces of peds	---	VPF
PORES (in pores, or associated with surfaces along pores)		
On surfaces along pores	---	SPO
Infused into the matrix adjacent to pores *(hypocoats)* [1]	---	MPO
Lining pores [1]	---	LPO
OTHER		
In cracks	C	CRK
Top of horizon	M	TOH
Around rock fragments	S	ARF
On bottom of rock fragments *(e.g., pendants)*	---	BRF

[1] See illustration under **Ped and Void Surface Features - Kind**.

CONCENTRATIONS - HARDNESS - Describe the relative force required to crush the concentration body. Use the dry, moist, or cementation condition appropriate to the natural condition of the feature (see “Rupture Resistence Table”); e.g., *Very Hard*; (exclude the *Loose* class). ***NOTE***: PDP doesn’t recognize the *Moderately Hard* class, dry nor moist (= *Very Weakly Cemented* class).

CONCENTRATIONS - BOUNDARY - The gradation between feature and matrix.

Class	Code	Criteria
Sharp	S	Color changes in < 0.1 mm; change is abrupt even under a 10X hand lens.
Clear	C	Color changes within 0.1 to < 2 mm; gradation is visible without 10X lens.
Diffuse	D	Color changes in ≥ 2 mm; gradation is easily visible without 10X hand lens.

PED & VOID SURFACE FEATURES

These features are coats/films, hypocoats, or stress features formed by translocation and deposition, or shrink-swell processes on or along surfaces. Describe **Kind**, **Amount Class** (percent in NASIS and PDP), **Distinctness**, **Location**, and **Color** (dry or moist). An example is: *many, faint, brown 10YR 4/6 (Moist), clay films on all faces of peds* or *m, f, 10YR 4/6 (M), CLF, PF*.

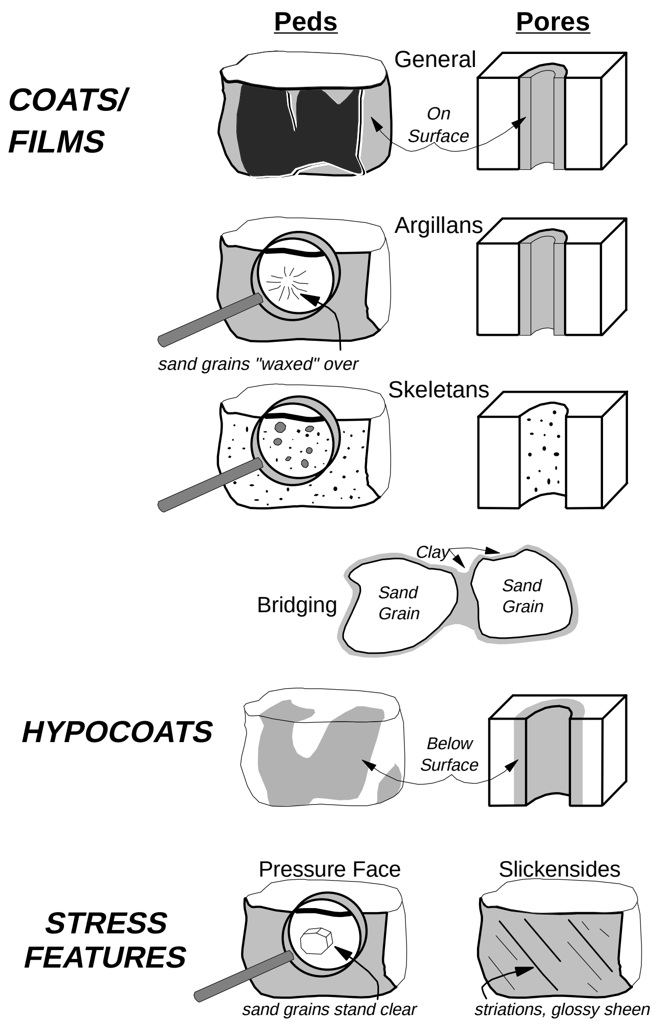
PED & VOID SURFACE FEATURES - KIND (non-redoximorphic) -

Kind	**Code** PDP	**Code** **NASIS**	**Field Criteria**
COATS, FILMS (exterior, adhered to surface)			
Carbonate Coats	K	CAF	off-white, effervescent with HCl
Silica (silans, opal)	--	SIF	off-white, noneffervesent with HCl
Clay Films (Argillans)	T	CLF	waxy, exterior coats
Clay Bridging	D	BRF	"wax" between grains
Ferriargillans Described as **RMF - Kind**		see RMFs	Fe^{+3} stained clay film
Gibbsite Coats (sesquan)	G	GBF	$AlOH_3$, off-white, noneffervescent with HCl
Manganese (mangans) Described as **RMF - Kind**		see RMFs	black, thin films effervescent with H_2O_2
Organic Stains	--	OSF	dark organic films
Organoargillans	O	OAF	dark, organic stained clay films
Sand Coats	Z	SNF	separate grains visible with 10X
Silt Coats [1]	R	SLF	separate grains not visible at 10X
Skeletans [2] (sand or silt)	S	SKF	clean sand or silt grains as coats
Skeletans on argillans	A	SAF	clean sand or silt over clay coats
HYPOCOATS [3] (A stain infused beneath a surface or a depletion halo. Hypocoats of Mn and Fe are described as Redoximorphic Features.)			
STRESS FEATURES (exterior face)			
Pressure faces (i.e. stress cutans)	P	PRF	look like clay films; sand grains uncoated
Slickensides	K	SS	slip face; grooves, striations, glossy or shiny

[1] Individual silt grains are not discernible with a 10X lens. Silt coats occur as a fine, off-white, noneffervescent, "grainy" coat on surfaces.

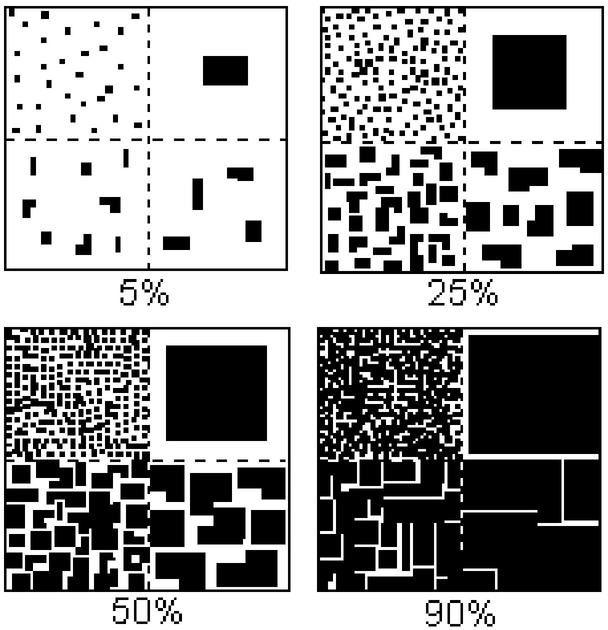
[2] Skeletans are (pigment) stripped grains > 2 µm and < 2 mm (Brewer, 1976). Preferably describe either silt coats (grains not discernible with 10X lens), or sand coats (grains discernible with 10X lens).

[3] Hypocoats, as used here, are field-scale features commonly expressed only as Redoximorphic Features. Micromorphological hypocoats include non-redox features (Bullock, et al., 1985).



PED & VOID SURFACE FEATURES - AMOUNT - Estimate the relative percent of the visible surface area that a ped-surface feature occupies in a horizon. (See graphic on next page.) In PDP & NASIS, record the estimate as a numeric percent; e.g., *20%*.

Amount Class	Code Conv.	Code NASIS	Criteria: percent of surface area
Very Few	vf	%	< 5 percent
Few	f	%	5 to < 25 percent
Common	c	%	25 to < 50 percent
Many	m	%	50 to < 90 percent
Very Many	vm	%	≥ 90 percent



PED & VOID SURFACE FEATURES - CONTINUITY (Obsolete in NRCS) - Replaced by **Ped & Void Surface Feature - Amount** in PDP.

Continuity Class	Code (Conv.)	Criteria: Features Occur As
Continuous	C	Entire Surface Cover
Discontinuous	D	Partial Surface Cover
Patchy	P	Isolated Surface Cover

PED & VOID SURFACE FEATURES - DISTINCTNESS - The relative extent to which a ped surface feature visually stands out from adjacent material.

Distinctness Class	Code	Criteria:
Faint	F	Visible with magnification only (10X hand lens); little contrast between materials.
Distinct	D	Visible without magnification; significant contrast between materials.
Prominent	P	Markedly visible without magnification; sharp visual contrast between materials.

PED & VOID SURFACE FEATURES - LOCATION - Specify where ped-surface features occur within a horizon; e.g., *Between sand grains*.

Location	Code PDP	Code NASIS
PEDS		
On Bottom Faces of Peds	L [1]	BF
On Top Faces of Peds	U [1]	TF
On Vertical Faces of Peds	V	VF
On All Faces of Peds *(vertical & horizonal)*	P	PF
On Tops of Soil Columns	C	TC
OTHER (NON-PED)		
Between Sand Grains *(bridging)*	B	BG
On Surfaces Along Pores	I [1]	SP
On Surfaces Along Root Channels	I [1]	SC
On Concretions	O	CC
On Nodules	N	NO
On Rock Fragments	R	RF
On Top Surfaces of Rock Fragments	U [1]	TR
On Bottom Surfaces of Rock Fragments	L [1]	BR

[1] Codes are repeated because these choices are combined in PDP.

PED & VOID SURFACE FEATURES - COLOR - Use standard Munsell® notation (hue, value, chroma) to record feature color.

(SOIL) TEXTURE

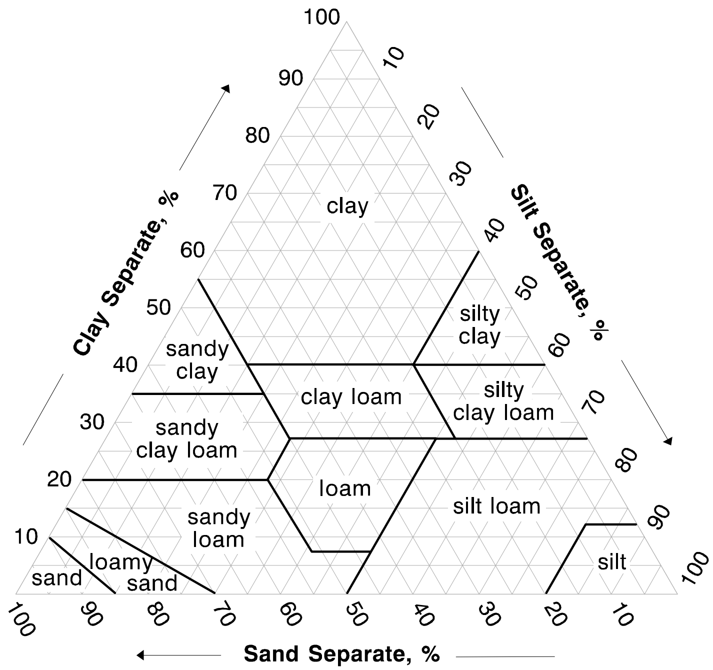
This is the numerical proportion (percent by weight) of sand, silt, and clay in a soil. Sand, silt, and clay content is estimated in the field by hand (or quantitatively measured in the office/lab by hydrometer or pipette) and then placed within the texture triangle to determine **Texture Class**. Estimate the **Texture Class**; e.g., *sandy loam*; or **Subclass**; e.g., *fine sandy loam* of the fine earth (< 2 mm) fraction, or choose a **Term in Lieu of Texture**; e.g., *gravel*. If appropriate, use a **Textural Class Modifier**; e.g., *gravelly silt loam*.

NOTE: **Soil Texture** encompasses only the fine earth fraction (< 2 mm). **Particle Size Distribution** (PSD) encompasses the whole soil, including both the fine earth fraction (< 2 mm) and rock fragments (> 2 mm).

TEXTURE CLASS -

Texture Class	Code	
	Conv.	**NASIS**
Coarse Sand	cos	COS
Sand	s	S
Fine Sand	fs	FS
Very Fine Sand	vfs	VFS
Loamy Coarse Sand	lcos	LCOS
Loamy Sand	ls	LS
Loamy Fine Sand	lfs	LFS
Loamy Very Fine Sand	lvfs	LVFS
Coarse Sandy Loam	cosl	COSL
Sandy Loam	sl	SL
Fine Sandy Loam	fsl	FSL
Very Fine Sandy Loam	vfsl	VFSL
Loam	l	L
Silt Loam	sil	SIL
Silt	si	SI
Sandy Clay Loam	scl	SCL
Clay Loam	cl	CL
Silty Clay Loam	sicl	SICL
Sandy Clay	sc	SC
Silty Clay	sic	SIC
Clay	c	C

Texture Triangle:
Fine Earth Texture Classes (——)



TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for **Rock Fragments - Size & Quantity**.

Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., *loam*).
15 to < 35	Use adjective for appropriate size; e.g., *gravelly*.
35 to < 60	Use "very" with the appropriate size adjective; e.g., *very gravelly*.
60 to < 90	Use "extremely" with the appropriate size adjective; e.g., *extremely gravelly*.
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., *gravel*. Use **Terms in Lieu of Texture**.

Relationships Among Particle Size Classes and Different Systems

	FINE EARTH								ROCK FRAGMENTS					
USDA[1]	Clay	Silt		Sand					Gravel			Cob-bles	Stones	Boulders
		fi.	co.	v.fi.	fi.	med.	co.	v. co.	fi.	med.	co.			

150 channers, 380 flagstones

Size (mm)	.002 mm · .02 · .05 · .1 · .25 · .5 · 1 · 2 mm · 5 · 20 · 76 · 250 mm · 600 mm
U.S. Standard Sieve No. (opening):	300 · 140 · 60 · 35 · 18 · 10 · 4 · (3/4") · (3") · (10") · (25")

International[2]	Clay	Silt	Sand		Gravel	Stones
			fi.	co.		

Size (mm): .002 mm · .02 · .25 · 2 mm · 20 mm

Unified[3]	Silt or Clay	Sand			Gravel		Cobbles	Boulders
		fi.	med.	co.	fi.	co.		

Size (mm): .074 · .42 · 2 mm · 4.8 · 19 · 76 · 300 mm

AASHTO[4,5]	Clay	Silt	Sand		Gravel or Stones			Broken Rock (angular), or Boulders (rounded)
			fi.	co.	fi.	med.	co.	

Size (mm)	.005 mm · .074 · .42 · 2 mm · 9.5 · 25 · 75 mm
U.S. Standard Sieve No. (opening):	200 · 40 · 10 · (3/8") · (1") · (3")

phi #:	12 · 10 · 9 · 8 · 7 · 6 · 5 · 4 · 3 · 2 · 1 · 0 · -1 · -2 · -3 · -4 · -5 · -6 · -7 · -8 · -9 · -10 · -12
Modified Wentworth[6]	clay · silt · sand · pebbles · cobbles · boulders
Size (mm)	.002 · .016 · .008 · .031 · .062 · .125 · .25 · .5 · 1 · 2 mm · 8 · 16 · 64 · 256 · 4092 mm
U.S. Standard Sieve No. (opening):	230 · 120 · 60 · 35 · 18 · 10 · 5

References for Table Comparing Particle Size Systems

[1] Soil Survey Staff. 1995. Soil survey laboratory information manual. USDA - Natural Resources Conservation Service, Soil Survey Investigations Report No. 45, Version 1.0, National Soil Survey Center, Lincoln, NE. 305 p.

[2] International Soil Science Society. 1993. *In*: Soil Survey Manual. Soil Survey Staff, USDA - Soil Conservation Service, Agricultural Handbook No. 18, U.S. Gov. Print. Office, Washington, D.C. 503 p.

[3] ASTM. 1993. Standard classification of soils for engineering purposes (Unified Soil Classification System). ASTM designation D2487-92. *In*: Soil and rock; dimension stone; geosynthetics. Annual book of ASTM standards - Vol. 04.08.

[4] ASSHTO. 1986a. Recommended practice for the classification of soils and soil-aggregate mixtures for highway construction purposes. ASSHTO designation M145-82. *In*: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.

[5] ASSHTO. 1986b. Standard definitions of terms relating to subgrade, soil-aggregate, and fill materials. ASSHTO designation M146-70 (1980). *In*: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.

[6] Ingram, R.L. 1982. Modified Wentworth scale. *In*: Grain-size scales. AGI Data Sheet 29.1. *In*: Dutro, J.T., Dietrich, R.V., and Foose, R.M. 1989. AGI data sheets for geology in the field, laboratory, and office, 3rd edition. American Geological Institute, Washington, D.C.

TEXTURE MODIFIERS - *(adjectives)*

ROCK FRAGMENTS: Size & Quantity [1]	Code PDP	Code Conv. / NASIS	Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (*name size*): [1]
HARD ROCK FRAGMENTS (> 2 mm)			
Gravelly	GR	GR	≥ 15% but < 35% gravel
Fine Gravelly	FGR	GRF	≥ 15% but < 35% fine gravel
Medium Gravelly	MGR	GRM	≥ 15% but < 35% med. gravel
Coarse Gravelly	CGR	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	VGR	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	XGR	GRX	≥ 60% but < 90% gravel
Cobbly	CB	CB	≥ 15% but < 35% cobbles
Very Cobbly	VCB	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	XCB	CBX	≥ 60% but < 90% cobbles
Stony	ST	ST	≥ 15% but < 35% stones
Very Stony	VST	STV	≥ 35% but < 60% stones
Extremely Stony	XST	STX	≥ 60% but < 90% stones
Bouldery	BY	BY	≥ 15% but < 35% boulders
Very Bouldery	VBY	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	XBY	BYX	≥ 60% but < 90% boulders
Channery	CN	CN	≥ 15% but < 35% channers
Very Channery	VCN	CNV	≥ 35% but < 60% channers
Extremely Channery	XCN	CNX	≥ 60% but < 90% channers
Flaggy	FL	FL	≥ 15% but < 35% flagstones
Very Flaggy	VFL	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	XFL	FLX	≥ 60% but < 90% flagstones
PARA (SOFT) ROCK FRAGMENTS (> 2 mm) [2, 3]			
Parabouldery	PBY	PBY	(same criteria as bouldery)
Very Parabouldery	VPBY	PBYV	(same criteria as very bouldery)
Ext. Parabouldery	XPBY	PBYX	(same criteria as ext. bouldery)
etc.	etc.	etc.	(same criteria as non -para)

[1] The “Quantity” modifier (e.g., *very*) is based on the total rock fragment content. The “Size” modifier (e.g., *cobble*) is based on the largest, dominant fragment size. For a mixture of sizes (e.g., *gravel and stones*), the smaller size must exceed 2X the amount of the larger size to be named (e.g., 30% gravel and 14% stones = *very gravelly*; 20% gravel and 14% stones = *stony*).

[2] Use “Para” prefix if the rock fragments are soft (i.e., meet criteria for “para”). [Rupture Resistance - Cementation Class < Moderately Cemented, and do not slake (24 hrs in water).]

[3] For "Para" codes, add "P" to "Size" and "Quantity" code terms. Precedes noun codes and follows quantity adjectives, e.g., paragravelly = *PGR*; very paragravelly = *VPGR*.

COMPOSITIONAL TEXTURE MODIFIERS [1] - *(adjectives)*

Types	Code PDP	Code NASIS	Criteria:
VOLCANIC			
Ashy	--	AS	Neither hydrous nor medial and ≥ 30% of the < 2 mm fraction is 0.02 to 2.00 mm in size of which ≥ 5% is volcanic glass
Hydrous	--	HY	Andic properties and with field moist 15 bar water content ≥ 100% of the dry weight
Medial	--	ME	Andic properties and with field moist 15 bar water content ≥ 30% to < 100% of the dry weight or ≥ 12% water content for air-dried samples
ORGANIC SOILS			
Grassy [2]	--	GS	OM > 15% (vol.) grassy fibers
Herbaceous [2]	--	HB	OM > 15% (vol.) herbaceous fibers
Mossy [2]	--	MS	OM > 15% (vol.) moss fibers
Mucky	MK	MK	Mineral soil > 10% OM and < 17% fibers
Peaty	PT	PT	Mineral soil > 10% OM with > 17% fibers
Woody [2]	--	WD	OM ≥ 15% (vol.) wood pieces or fibers
OTHER			
Coprogenous	--	CO	
Diatomaceous	--	DI	
Gypsiferous	--	GY	≥ 15% (weight) gypsum
Marly	--	MA	
Permanently Frozen	PF	PF	Permafrost

[1] **Compositional Texture Modifiers** can be used with the **Soil Texture Name**; e.g., *gravelly ashy loam* or *mossy peat*. For definitions and usage of **Compositional Texture Modifiers**, see the National Soil Survey Handbook - Part 618 (Soil Survey Staff, 1996c).

[2] Used only with Histosols, histic epipedons, or mucky peats and peats.

TERMS USED IN LIEU OF TEXTURE - *(nouns)*

Terms Used in Lieu of Texture	Code PDP	Code NASIS
SIZE (HARD ROCKS)		
Gravel	G	GR
Cobbles	CB	CB
Stones	ST	ST
Boulders	B	BY
Channers	--	CN
Flagstones	--	FL
SIZE (SOFT ROCKS)		
Paragravel	--	PG
Paracobbles	--	PC
Parastones	--	PS
Paraboulders	--	PB
Parachanners	--	PN
Paraflagstones	--	PF
COMPOSITION		
Cemented / Consolidated:		
Duripan *(silica cement)*	--	DU
Ortstein *(organic with Fe and Al cement)*	--	OR
Petrocalcic *(carbonate cement)*	--	TC
Petroferric *(Fe cement)*	--	TF
Petrogypsic *(gypsum cement)*	--	TG
Placic Horizon *(thin layer cemented by Fe & Mn)*	--	PL
Unweathered Bedrock *(unaltered)*	UWB	UB
Weathered Bedrock *(altered; Cr horizons)*	WB	WB
Organics:		
Highly Decomposed Plant Material *(Oa)* [1]	---	HM
Moderately Decomposed Plant Material *(Oe)* [1]	---	MM
Slightly Decomposed Plant Material *(Oi)* [1]	---	SM
Muck [2] *(≈Oa)*	---	MU
Mucky Peat [2] *(≈Oe)*	---	MP
Peat [2] *(≈Oi)*	---	PT
Other:		
Finely Stratified *(contrasting textures)*	--	FS
Ice *(permanently frozen)* [3]	--	IC
Water *(permanent)* [3]	--	WA

[1] Use only with mineral soil layers.
[2] Use only with Histosols or histic epipedons.
[3] Use only for layers found below the soil surface.

ROCK and OTHER FRAGMENTS

These are discrete, water-stable particles > 2 mm. Hard Rock Fragments have a Rupture Resistance - Cementation Class ≥ Strongly Cemented. Other Fragments (e.g., soft rock, wood) are less strongly cemented. Describe **Kind**, **Volume Percent** (classes given below), **Roundness or Shape**, and **Size** (mm).

ROCK AND OTHER FRAGMENTS - KIND - Use the choice list given for **Bedrock - Kind** and the additional choices in the table below. ***NOTE***: Interbedded rocks from the "Bedrock - Kind Table" are not appropriate choices or terminology for rock fragments.

Kind	Code		Kind	Code	
	PDP	**NASIS**		PDP	**NASIS**
Includes all choices in **Bedrock - Kind** (except *Interbedded*), plus:					
Calcrete *(caliche)* [1]	---	CA	Scoria	---	SC
Charcoal	---	CH	Volcanic bombs	---	VB
Cinders	E5	CI	Wood	---	WO
Lapilli	---	LA			

[1] Fragments strongly cemented by carbonate, may include fragments derived from petrocalcic horizons.

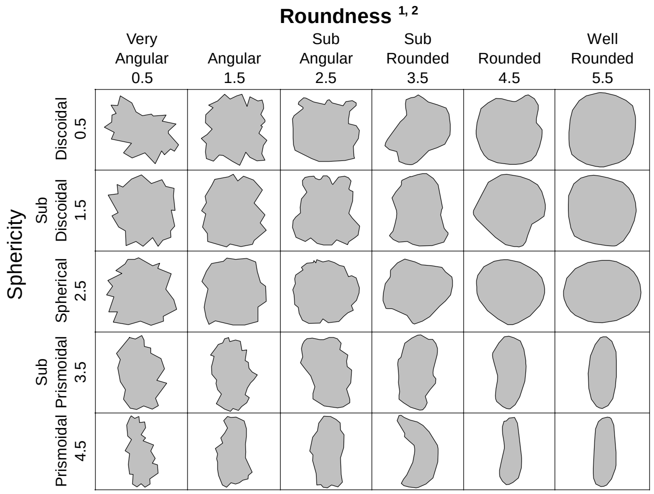
ROCK AND OTHER FRAGMENTS - VOLUME PERCENT - Estimate the quantity on a volume percent basis. ***NOTE***: For proper use of **Texture Modifiers**, refer to the "Percent Volume Table" found under **Texture**.

ROCK AND OTHER FRAGMENTS - ROUNDNESS - Estimate the relative roundness of rock fragments; use the following classes. (Called **Fragment Roundness** in PDP.)

Roundness Class	Code		Criteria: visual estimate [1]
	PDP	**NASIS**	
Very Angular	---	VA	*Use **Roundness** graphic on next page*
Angular	1	AN	
Subangular	2	SA	
Subrounded	3	SR	
Rounded	4	RO	
Well Rounded	5	WR	

[1] The criteria consist of a visual estimation; use the following graphic.

Estimate the relative rounding of rock fragments. (Ideally, use the average roundness based on 50 or more fragments.) The conventional geologic and engineering approach is presented in the following graphic. (***NOTE***: NRCS does <u>not</u> quantify **Sphericity**. It is included here for completeness and to show the range in **Fragment Roundness**.)



[1] After Powers, 1953.

[2] Numerical values below *roundness* and *sphericity* columns are class midpoints (median rho values) (Folk, 1955) used in statistical analysis.

ROCK AND OTHER FRAGMENTS - SIZE CLASSES AND DESCRIPTIVE TERMS -

Size [1]	Noun	Adjective [2]
SHAPE - SPHERICAL or CUBELIKE (discoidal, subdiscoidal, or spherical)		
> 2 - 75 mm diameter	gravel	gravelly
> 2 - 5 mm diameter	fine gravel	fine gravelly
> 5 - 20 mm diameter	medium gravel	medium gravelly
> 20 - 75 mm diameter	coarse gravel	coarse gravelly
> 75 - 250 mm diameter	cobbles	cobbly
> 250 - 600 mm diameter	stones	stony
> 600 mm diameter	boulders	bouldery
SHAPE - FLAT (prismoidal or subprismoidal)		
> 2 - 150 mm long	channers	channery
> 150 - 380 mm long	flagstones	flaggy
> 380 - 600 mm long	stones	stony
> 600 mm long	boulders	bouldery

[1] Fragment size is measured by sieves; class limits have a > lower limit.
[2] For a mixture of sizes (e.g., gravels and stones present), the smaller size must exceed 2X the quantity of the larger size (e.g., 30% gravel and 14% stones = *gravelly*; but 20% gravel and 14% stones = *stony*).

(SOIL) STRUCTURE

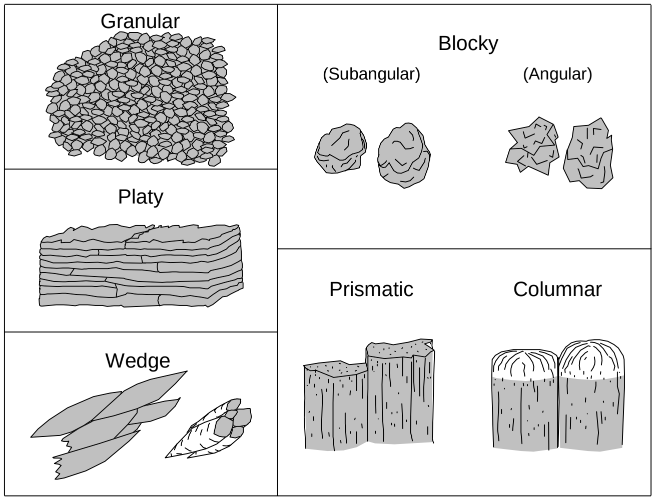
(Soil) Structure is the naturally occurring arrangement of soil particles into aggregates that results from pedogenic processes. Record **Grade**, **Size**, and **Type**. For compound structure, list each **Size** and **Type**; e.g., *medium and coarse SBK parting to fine GR*. Up to ten entries (per horizon) are permitted in PDP4. (For PDP only, estimate the percent of each type.) Lack of structure (structureless) has two end members: *massive (MA)* or *single grain (SG)*. A complete example is: *weak, fine, subangular blocky* or *1, f, sbk*.

(SOIL) STRUCTURE - TYPE (formerly **Shape**) -

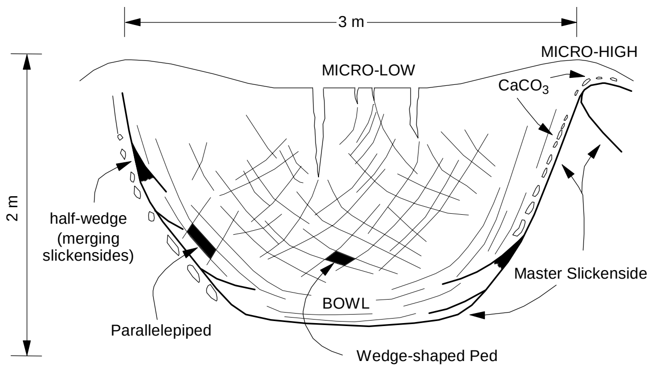
Type	Code Conv	NASIS	Criteria: definition
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)			
Granular	gr	GR	Small polyhedrals, with curved or very irregular faces.
Angular Blocky	abk	ABK	Polyhedrals with faces that intersect at sharp angles (planes).
Subangular Blocky	sbk	SBK	Polyhedrals with sub-rounded and planar faces, lack sharp angles.
Platy	pl	PL	Flat and tabular-like units.
Wedge	---	WEG	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials.
Prismatic	pr	PR	Vertically elongated units with flat tops.
Columnar	cpr	COL	Vertically elongated units with rounded tops which commonly are “bleached”.
STRUCTURELESS			
Single Grain	sg	SGR	No structural units; entirely noncoherent; e.g., loose sand.
Massive	m	MA	No structural units; material is a coherent mass (not necessarily cemented).
ARTIFICIAL EARTHY FRAGMENTS OR CLODS [1] (non-pedogenic structure)			
Cloddy [1]	---	CDY	Irregular blocks created by artificial disturbance; e.g., tillage or compaction.

[1] Used only to described oversized, “artificial” earthy units that are not pedogenically derived soil structural units; e.g., the direct result of mechanical alteration; use **Blocky Structure Size** criteria.

Examples of Soil Structure Types



Example of Wedge Structure, Gilgai Microfeatures, & Microrelief



Modified from: Lynn and Williams, Soil Survey Horizons, 1992.

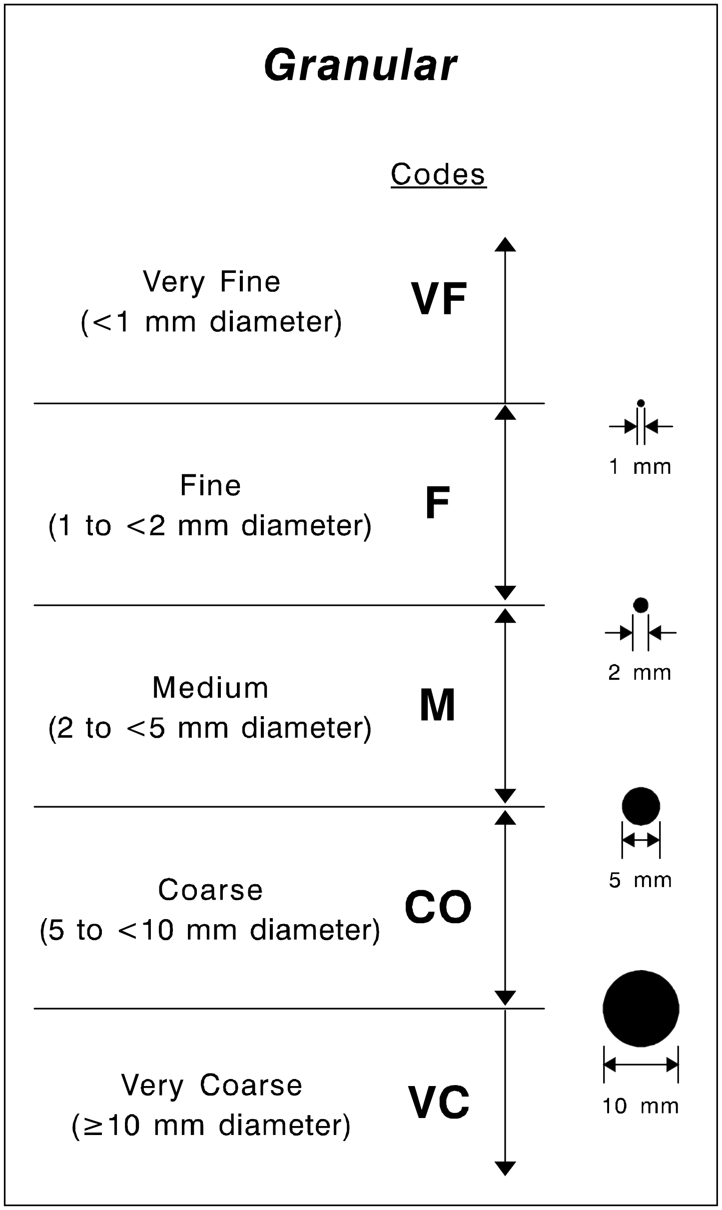
(SOIL) STRUCTURE - GRADE -

Grade	Code	Criteria
Structureless	0	No discrete units observable in place or in hand sample.
Weak	1	Units are barely observable in place or in a hand sample.
Moderate	2	Units well-formed and evident in place or in a hand sample.
Strong	3	Units are distinct in place (undisturbed soil), and separate cleanly when disturbed.

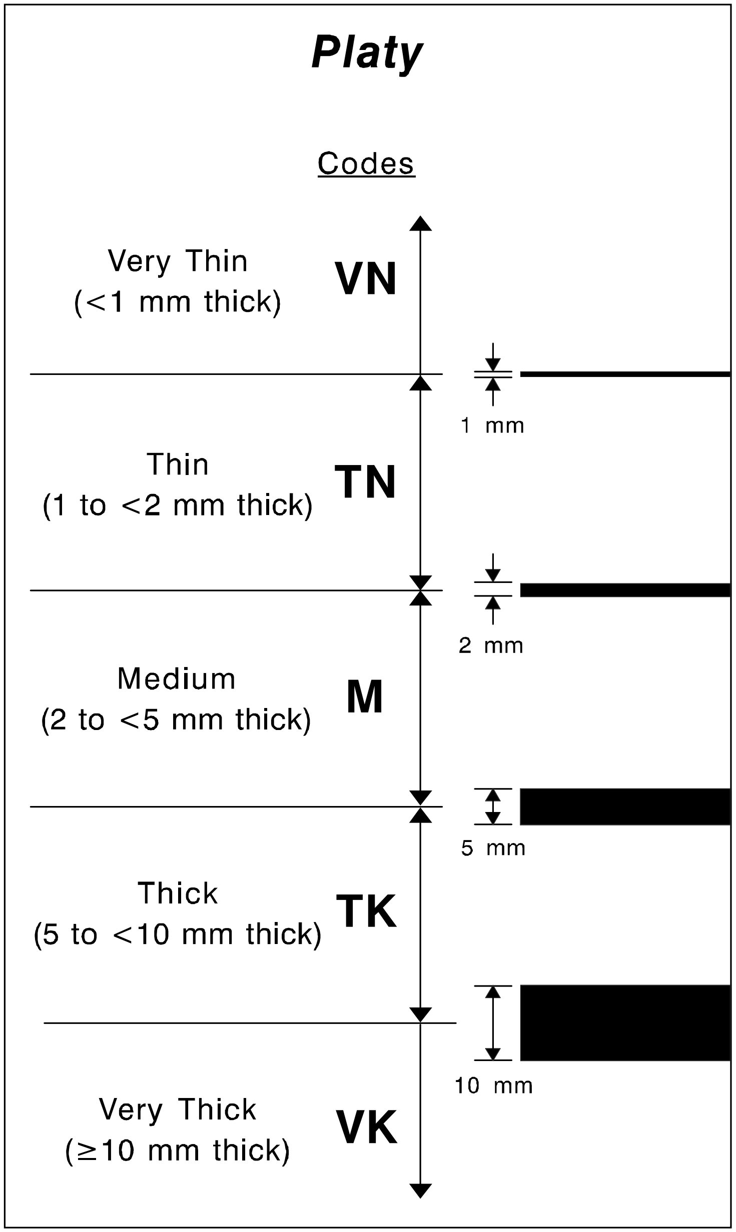
(SOIL) STRUCTURE - SIZE -

Size Class	Code Conv	Code NASIS	Criteria: structural unit size [1] (mm) Granular Platy [2] Thickness	Columnar, Prismatic, Wedge [3]	Angular & Subangular Blocky
Very Fine (Very Thin [2])	vf (vn [1])	VF (VN [1])	< 1	< 10	< 5
Fine (Thin [1])	f (tn [1])	F (TN [1])	1 to < 2	10 to < 20	5 to < 10
Medium	m	M	2 to < 5	20 to < 50	10 to < 20
Coarse (Thick [2])	co (tk [2])	CO (TK [2])	5 to < 10	50 to < 100	20 to < 50
Very Coarse (Very Thick)	vc (vk [2])	VC (VK [2])	≥ 10	100 to < 500	≥ 50
Ext. Coarse	ec	EC	---	≥ 500	---

[1] Size limits always denote the smallest dimension of the structural units.
[2] For platy structure only, substitute *thin* for *fine* and *thick* for *coarse* in the size class names.
[3] Wedge structure is generally associated with Vertisols (for which it is a requirement) or related soils with high amounts of smectitic clays.

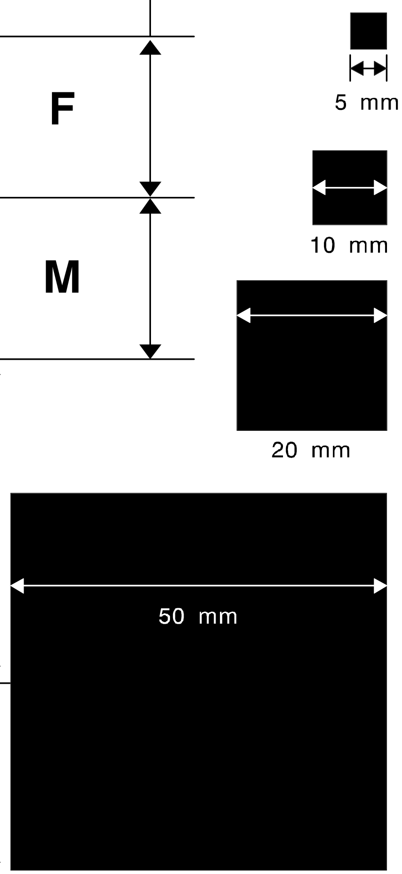


Granular
Codes
Very Fine
(<1 mm diameter)
VF
Fine
(1 to <2 mm diameter)
F
Medium
(2 to <5 mm diameter)
M
Coarse
(5 to <10 mm diameter)
CO
Very Coarse
(≥10 mm diameter)
VC
1 mm
2 mm
5 mm
10 mm

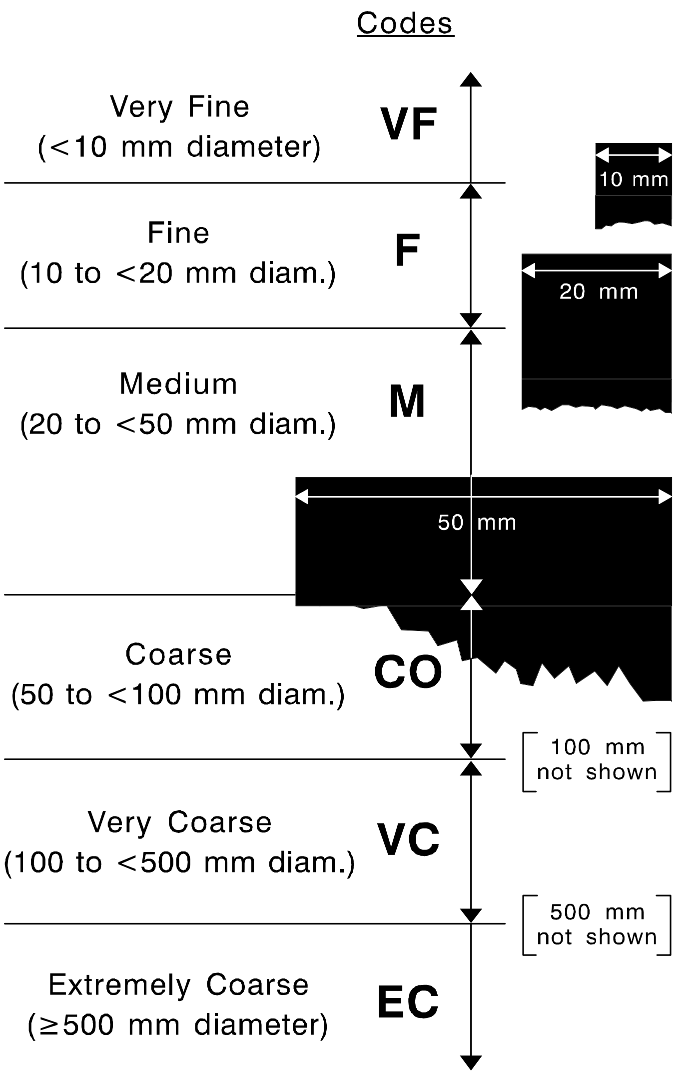

Platy
Codes
Very Thin
(<1 mm thick)
VN
1 mm
Thin
(1 to <2 mm thick)
TN
2 mm
Medium
(2 to <5 mm thick)
M
5 mm
Thick
(5 to <10 mm thick)
TK
10 mm
Very Thick
(≥10 mm thick)
VK

Angular & Subangular Blocky

	Codes
Very Fine (<5 mm diameter)	**VF**
Fine (5 to <10 mm diameter)	**F**
Medium (10 to <20 mm diameter)	**M**
Coarse (20 to <50 mm diameter)	**CO**
Very Coarse (≥50 mm diam.)	**VC**

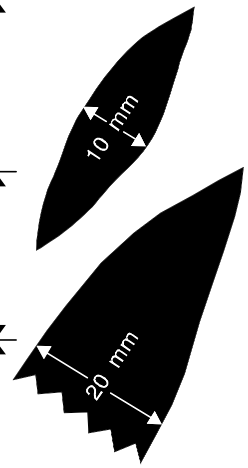


Prismatic & Columnar



Wedge

	Codes
Very Fine (<10 mm thick)	**VF**
Fine (10 to <20 mm thick)	**F**
Medium (20 to <50 mm thick)	**M**
Coarse (50 to <100 mm thick)	**CO**
Very Coarse (100 to <500 mm thick)	**VC**
Extremely Coarse (≥500 mm thick)	**EC**



50 mm not shown

100 mm not shown

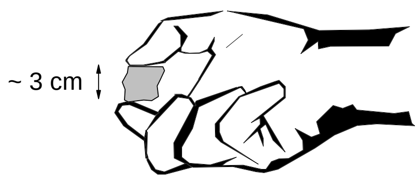
500 mm not shown

CONSISTENCE

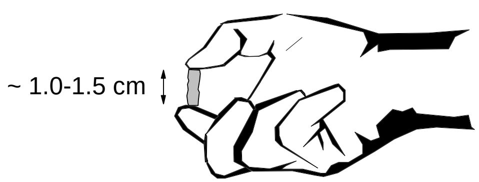
Consistence is the degree and kind of cohesion and adhesion that soil exhibits, and/or the resistance of soil to deformation or rupture under an applied stress. Soil-water state strongly influences consistence. Field evaluations of consistence include: **Rupture Resistance** (Blocks, Peds, and Clods; or Surface Crusts and Plates), **Resistance to Penetration**, **Plasticity**, **Stickiness**, and **Manner of Failure**. Historically, consistence applied to dry, moist, or wet soil as observed in the field. Wet consistence evaluated stickiness and plasticity. **Rupture Resistance** now applies to dry soils and to soils in a water state from moist through wet. **Stickiness** and **Plasticity** of soil are independent evaluations.

RUPTURE RESISTANCE - A measure of the strength of soil to withstand an applied stress. Separate estimates of **Rupture Resistance** are for made **Blocks/Peds/Clods** and for **Surface Crusts and Plates** of soil. Block-shaped specimens should be approximately 2.8 cm across. If 2.8 cm cubes (e.g., ≈ 2.5 - 3.1 cm) are not obtainable, use the following equation and the table below to calculate the stress at failure: [(2.8 cm / cube length cm)^2 X estimated stress (N) at failure)]; e.g., *for a 5.6 cm cube [(2.8/5.6)^2 X 20 N = 5 N ⇒ Soft Class*. Plate-shaped specimens (surface crusts or platy structure) should be approximately 1.0 - 1.5 cm long by 0.5 cm thick (or the thickness of occurrence, if < 0.5 cm thick).

Blocks/Peds



Crusts/Plates



Blocks, Peds, and Clods - Estimate the class by the force required to rupture (break) a soil unit. Select the column for the appropriate soil moisture condition (*dry* vs. *moist*) and / or the *Cementation* column, if applicable.

Dry		**Moist**		**Cementation** [1]		**Specimen**
Class	Code [2]	Class	Code [2]	Class	Code [2]	**Fails Under**
Loose	L d(lo)	Loose	L m(lo)	*Not Applicable*		*Intact specimen not obtainable*
Soft	S d(so)	Very Friable	VFR m(vfr)	Non-Cemented	NC	Very slight force between fingers. <8 N
Slightly Hard	SH d(sh)	Friable	FR m(fr)	Extremely Weakly Cemented	EW	Slight force between fingers. 8 to < 20 N
Mod. Hard	MH d(h)	Firm	FI m(fi)	Very Weakly Cemented	VW	Moderate force between fingers. 20 to < 40 N
Hard	HA d(h)	Very Firm	VFI m(vfi)	Weakly Cemented	W c(w)	Strong force between fingers. 40 to < 80 N
Very Hard	VH d(vh)	Extr. Firm	EF m(efi)	Moderately Cemented	M	Moderate force between hands. 80 to < 160 N
Extremely Hard	EH d(eh)	Slightly Rigid	SR m(efi)	Strongly Cemented	ST c(s)	Foot pressure by full body weight. 160 to < 800 N
Rigid	R d(eh)	Rigid	R m(efi)	Very Strongly Cemented	VS	Blow of < 3 J but not body weight. 800 N to < 3 J
Very Rigid	VR d(eh)	Very Rigid	VR m(efi)	Indurated	I c(I)	Blow of ≥ 3 J. *(3 J = 2 kg weight dropped 15 cm).*

[1] This is not a field test; specimen must be air dried overnight and then submerged in water for a minimum of 1 hour prior to test.

[2] Codes in parentheses are obsolete criteria (Soil Survey Staff, 1951).

Soil Moisture Status (Consistence) (OBSOLETE) - Historical classes (Soil Survey Staff, 1953).

(d)[1] Dry Soil		(m)[1] Moist Soil		Cementation	
Class [2]	Code	Class	Code	Class	Code
Loose	(d) lo	Loose	(m) lo	Weakly Cemented	(c) w
Soft	(d) so	Very Friable	(m) vfr		
Slightly Hard	(d) sh	Friable	(m) fr	Strongly Cemented	(c) s
Hard [2]	(d) h	Firm	(m) fi		
Very Hard	(d) vh	Very Firm	(m) vfi	Indurated	(c) I
Ext. Hard	(d) eh	Ext. Firm	(m) efi		

[1] Historically, consistence prefixes (*d* for dry, *m* for moist) were commonly omitted, leaving only the root code; e.g., *vfr* for *mvfr*.
[2] *Hard Class (Dry)* was split into *Moderately Hard* and *Hard* (Soil Survey Staff, 1993).

Surface Crust and Plates -

Class - (air dried)	Code	Force [1] (Newtons)
Extremely Weak	EW	*Not Obtainable*
Very Weak	VW	Removable, < 1N
Weak	W	1 to < 3N
Moderate	M	3 to < 8N
Moderately Strong	MS	8 to < 20N
Strong	S	20 to < 40N
Very Strong	VS	40 to < 80N
Extremely Strong	ES	≥ 80N

[1] For operational criteria [field estimates of force (N)] use the *Fails Under* column, in the "Rupture Resistance for Blocks, Peds, Clods Table".

CEMENTING AGENTS - Record kind of cementing agent, if present.

Kind	Code [1]
carbonates	K
gypsum	G
humus	H
iron	I
silica (SiO_2)	S

[1] Conventional codes traditionally consist of the entire material name or its chemical symbols; e.g., *silica* or *SiO_2*. Consequently, the *Conv.* code column would be redundant and is not shown in this table.

MANNER OF FAILURE - The rate of change and the physical condition soil attains when subjected to compression. Samples are moist or wetter.

Failure Class	Code PDP	Code NASIS	Criteria: Related Field Operation
BRITTLENESS			***Use a 3 cm block. (Press between thumb & forefinger.)***
Brittle	B	BR	Ruptures abruptly ("pops" or shatters).
Semi-Deformable	SD	SD	Rupture occurs before compression to < 1/2 original thickness.
Deformable	D	DF	Rupture occurs after compression to ≥ 1/2 original thickness.
FLUIDITY			***Use a palmful of soil. (Squeeze in hand.)***
Nonfluid	NF	NF	No soil flows through fingers with full compression.
Slightly Fluid	SF	SF	Some soil flows through fingers, most remains in the palm, after full pressure.
Moderately Fluid	MF	MF	Most soil flows through fingers, some remains in palm, after full pressure.
Very Fluid	VF	VF	Most soil flows through fingers, very little remains in palm, after gentle pressure.
SMEARINESS			***Use a 3 cm block. (Press between thumb & forefinger.)***
Non-Smeary [1]	NS	NS	At failure, the sample does not change abruptly to fluid, fingers do not skid, no smearing occurs.
Weakly Smeary [1]	WS	WS	At failure, the sample changes abruptly to fluid, fingers skid, soil smears, little or no water remains on fingers.
Moderately Smeary [1]	MS	MS	At failure, the sample changes abruptly to fluid, fingers skid, soil smears, some water remains on fingers.
Strongly Smeary [1]	SM	SM	At failure, the sample abruptly changes to fluid, fingers skid, soil smears and is slippery, water easily seen on fingers.

[1] *Smeary* failure classes are used dominantly with Andic materials, but may also be used with some spodic materials.

STICKINESS - The capacity of soil to adhere to other objects. Stickiness is estimated at the moisture content that displays the greatest adherence when pressed between thumb and forefinger.

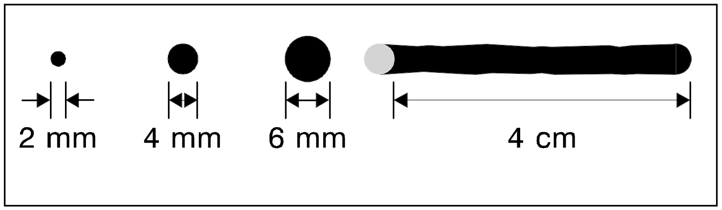
Stickiness Class	Code Conv	Code PDP	Code NASIS	Criteria: Work moistened soil between thumb and forefinger
Non-Sticky	(w) so	SO	SO	Little or no soil adheres to fingers, after release of pressure.
Slightly Sticky	(w) ss	SS	SS	Soil adheres to both fingers, after release of pressure. Soil stretches little on separation of fingers.
Moderately Sticky [1]	(w) s	S	MS	Soil adheres to both fingers, after release of pressure. Soil stretches some on separation of fingers.
Very Sticky	(w) vs	VS	VS	Soil adheres firmly to both fingers, after pressure release. Soil stretches greatly upon separation of fingers.

[1] Historically, the *moderately sticky* class was simply called *sticky*.

PLASTICITY - The degree to which "puddled" or reworked soil can be permanently deformed without rupturing. The evaluation is made by forming a roll (wire) of soil at a water content where the maximum plasticity is expressed.

Plasticity Class	Code Conv	Code PDP	Code NASIS	Criteria: Make a roll of soil 4 cm long
Non-Plastic	(w) po	PO	PO	Will not form a 6 mm diameter roll, or if formed, can't support itself if held on end.
Slightly Plastic	(w) ps	SP	SP	6 mm diameter roll supports itself; 4 mm diameter roll does not.
Moderately Plastic [1]	(w) p	P	MP	4 mm diameter roll supports itself, 2 mm diameter roll does not.
Very Plastic	(w) vp	VP	VP	2 mm diameter roll supports its weight.

[1] Historically, the *moderately plastic* class was simply called *plastic*.



PENETRATION RESISTANCE - The ability of soil in a confined (field) state to resist penetration by a rigid object of specified size. A pocket penetrometer (Soil-Test Model CL-700) with a rod diameter of 6.4 mm (area 20.10 mm^2) and insertion distance of at least 6.4 mm (note line on rod) is used for the determination. An average of five or more measurements should be used to obtain a value for penetration resistance. In PDP, record the **Penetration Resistance** value in mega-pascals (MPa), **Orientation** of the rod (vertical or horizontal), and **Water State** of the soil.

NOTE: The pocket penetrometer has a scale of 0.25 to 4.5 tons/ft^2 (tons/ft^2 $\approx$ kg/cm^2). The penetrometer does <u>not</u> directly measure penetration resistance. The penetrometer scale is correlated to, and gives a field estimate of <u>unconfined compressive strength</u> of soil as measured with a Tri-Axial Shear device. The table below converts the scale reading on the pocket penetrometer to penetration resistance in MPa. Penetrometer readings are dependent on the spring type used. Springs of varying strength are needed to span the range of penetration resistance found in soil.

Penetrometer Scale Reading	**Spring Type** [1, 2, 3]			
	Original MPa	Lee MPa	Jones 11 MPa	Jones 323 MPa
0.25	**0.32 L**	**0.06 VL**	**1.00 M**	**3.15 H**
0.75	0.60	**0.13 L**	1.76	4.20
1.00	0.74	0.17	**2.14 H**	4.73
1.50	**1.02 M**	0.24	2.90	5.78
2.75	1.72	0.42	4.80	**8.40 EH**
3.50	**2.14 H**	0.53	---	---

[1] On wet or "soft" soils a larger foot may be used (Soil Survey Staff, 1993).

[2] Each bolded value highlights the force associated with a rounded value on the penetrometer scale that is closest to a *Penetration Resistance Class* boundary. The bolded letter; e.g., **M**, represents the moderate *Penetration Resistance Class* from the following table.

[3] Each spring type spans only a part of the range of penetration resistance possible in soils; various springs are needed to span all *Penetration Resistance Classes*.

Penetration Resistance Class	Code	Criteria: Penetration Resistance (MPa)
Extremely Low	EL	< 0.01
Very Low	VL	0.01 to < 0.1
Low	L	0.1 to < 1
Moderate	M	1 to < 2
High	H	2 to < 4
Very High	VH	4 to < 8
Extremely High	EH	≥ 8

EXCAVATION DIFFICULTY - The relative force or energy required to dig soil out of place. Describe the **Excavation Difficulty Class** and the moisture condition (*moist* or *dry*, but not wet); use the "(Soil) Water State Table"; e.g., *moderate, moist* or *M, M*. Estimates can be made for either the most limiting layer or for each horizon.

Class	Code	Criteria
Low	L	Excavation by tile spade requires arm pressure only; impact energy or foot pressure is not needed.
Moderate	M	Excavation by tile spade requires impact energy or foot pressure; arm pressure is insufficient.
High	H	Excavation by tile spade is difficult, but easily done by pick using over-the-head swing.
Very High	VH	Excavation by pick with over-the-head swing is moderately to markedly difficult. Backhoe excavation by a 50-80 hp tractor can be made in a moderate time.
Extremely High	EH	Excavation via pick is nearly impossible. Backhoe excavation by a 50-80 hp tractor cannot be made in a reasonable time.

Record the **Quantity**, **Size**, and **Location** of roots in each horizon. ***NOTE***: Describe **Pores** using the same **Quantity** and **Size** classes and criteria as **Roots** (use the combined tables). A complete example for roots is: *Many, fine, roots In Mat at Top of Horizon* or *3, f (roots), M*.

ROOTS - QUANTITY (Roots and Pores) - Describe the quantity (number) of roots for each size class in a horizontal plane. (***NOTE***: Typically, this is done across a vertical plane, such as a pit face.) Record the average quantity from 3 to 5 representative unit areas. ***CAUTION***: The unit area that is evaluated varies with the *Size Class* of the roots being considered. Use the appropriate unit area stated in the *Soil Area Observed* column of the "Size (Roots and Pores) Table". In NASIS and PDP, record the actual number of roots/unit area (which outputs the appropriate class). Use class names in narrative description.

Quantity Class [1]	**Code** Conv	NASIS	**Average Count** [2] (per unit area)
Few	1	#	< 1 per area
Very Few [1]	---	#	< 0.2 per area
Moderately Few [1]	---	#	0.2 to < 1 per area
Common	2	#	1 to < 5 per area
Many	3	#	≥ 5 per area

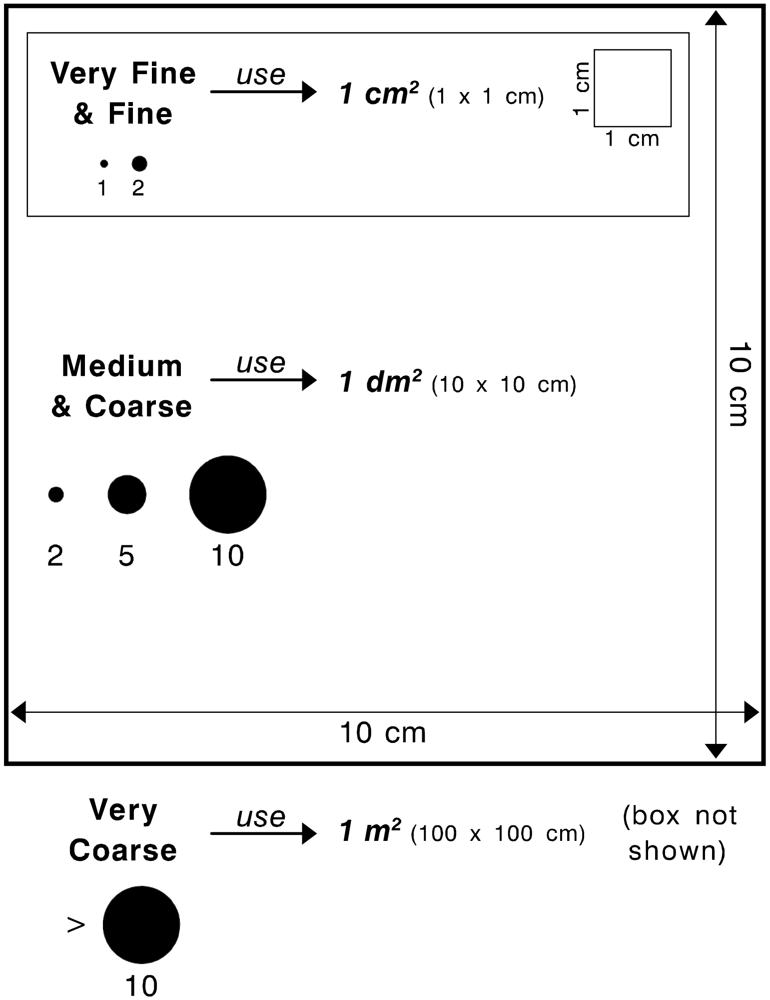
[1] The *Very Few* and *Moderately Few* sub-classes can be described for roots (optional) but do not apply to pores.
[2] The applicable area for appraisal varies with the size of roots or pores. Use the appropriate area stated in the *Soil Area Assessed* column of the "Size (Roots and Pores) Table" or use the following graphic.

ROOTS - SIZE (Roots and Pores) - See the following graphic for size.

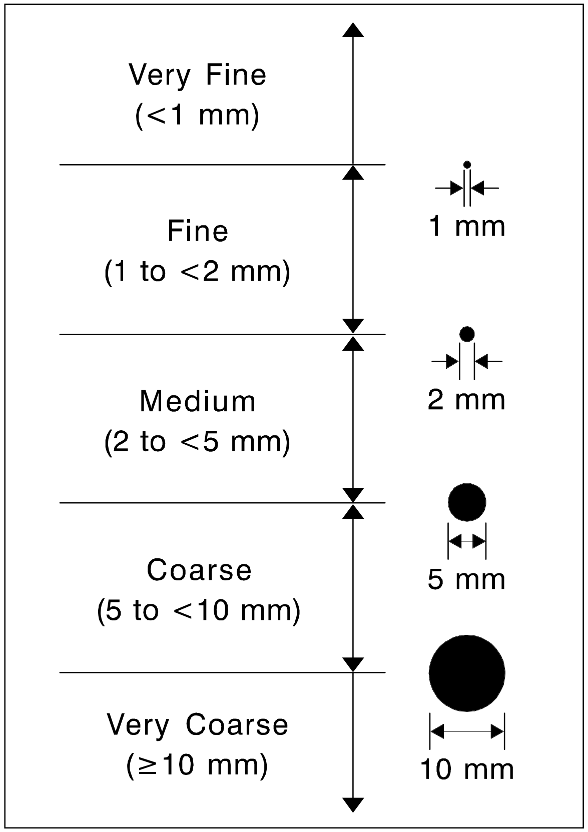
Size Class	**Code** Conv	NASIS	**Diameter**	**Soil Area** [1] **Assessed**
Very Fine	vf	VF	< 1 mm	1 cm^2
Fine	f	F	1 to < 2 mm	1 cm^2
Medium	m	M	2 to < 5 mm	1 dm^2
Coarse	co	C	5 to < 10 mm	1 dm^2
Very Coarse	vc	VC	≥ 10 mm	1 m^2

[1] One dm^2 = a square that is 10 cm on a side, or 100 cm^2.

ROOTS - QUANTITY (Roots and Pores) - Soil area to be assessed.



Root and Pore Size Classes



ROOTS - LOCATION (Roots) -

Location	Code
Between Peds	P
In Cracks	C
Throughout	T
In Mat at Top of Horizon [1]	M
Matted Around Rock Fragments	R

[1] Describing a root mat at the top of a horizon rather than at the bottom or within the horizon, flags the horizon that restricts root growth.

PORES DISCUSSION

Pores are the air or water filled voids in soil. Historically, description of soil pores, called "nonmatrix" pores in the Soil Survey Manual (Soil Survey Staff, 1993), excluded inter-structural voids, cracks, and in some schemes, interstitial pores. *Inter-structural voids* (i.e., the sub-planar fractures between peds; also called interpedal or structural faces/planes), which can be inferred from soil structure descriptions, are not recorded directly. *Cracks* can be assessed independently (Soil Survey Staff, 1993). *Interstitial pores* (i.e. visible, primary packing voids) may be visually estimated, especially for fragmental soils, or can be inferred from soil porosity, bulk density, and particle size distribution. Clearly, one cannot assess the smallest interstitial pores (e.g., < 0.05 mm) in the field. Field observations are limited to those that can be seen through a 10X hands lens, or larger. Consequently, field estimates of interstitial pores are considered to be somewhat tenuous, but useful.

PORES

Record **Quantity** and **Size** of pores for each horizon. Description of soil pore **Shape** and **Vertical Continuity** is optional. A complete example for pores is: *common, medium, tubular pores, throughout* or *c, m, TU (pores), T*.

PORES - QUANTITY - See and use **Quantity (Roots and Pores)**.

PORES - SIZE - See and use **Size (Roots and Pores)**.

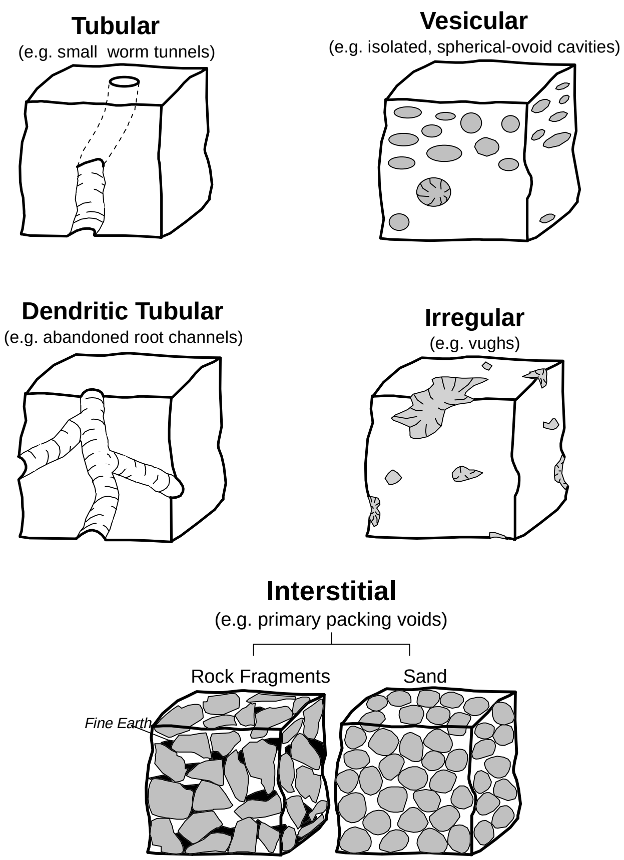
PORES - SHAPE (or Type) - Record the dominant form (also called "type") of pores discernible with a 10X hand lens and by the unaided eye. See the following graphic.

Description	**Code** PDP	**NASIS**	**Criteria**
SOIL PORES [1]			
Dendritic Tubular	TE	DT	Cylindrical, elongated, branching voids; e.g., *empty root channels*.
Irregular	---	IR	Non-connected cavities, chambers; e.g., *vughs*; various shapes.
Tubular	TU	TU	Cylindrical and elongated voids; e.g., *worm tunnels*.
Vesicular	VS	VE	Ovoid to spherical voids; e.g., *solidified pseudomorphs of entrapped, gas bubbles concentrated below a crust*; most common in arid to semi-arid environments.

***PRIMARY PACKING VOIDS* [2]**			
Interstitial	IR	IN	Voids between sand grains or rock fragments.

[1] Called “Nonmatrix Pores” in the Soil Survey Manual (Soil Survey Staff, 1993).

[2] *Primary Packing Voids* include a continuum of sizes. As used here, they have a minimum size that is defined as pores that are visible with a 10X hand lens. *Primary Packing Voids* are called “Matrix Pores” in the Soil Survey Manual (Soil Survey Staff, 1993).

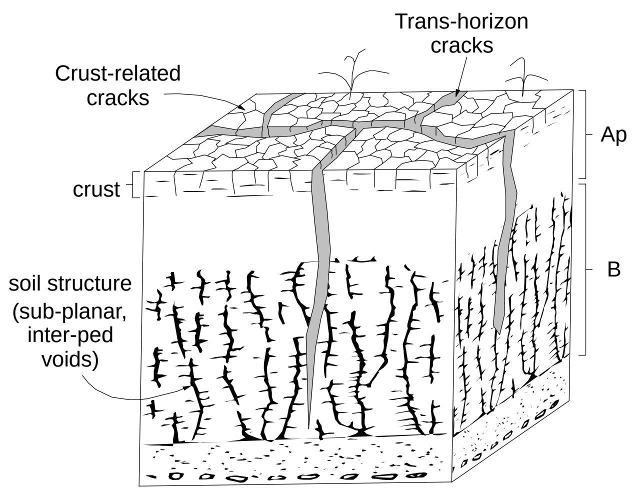


PORES - VERTICAL CONTINUITY - The average vertical distance through which the minimum pore diameter exceeds 0.5 mm. Soil must be moist or wetter.

Class	Code		Criteria:
	Conv.	NASIS	vertical distance
Low	---	L	< 1 cm
Moderate	---	M	1 to < 10 cm
High	---	H	≥ 10 cm

CRACKS

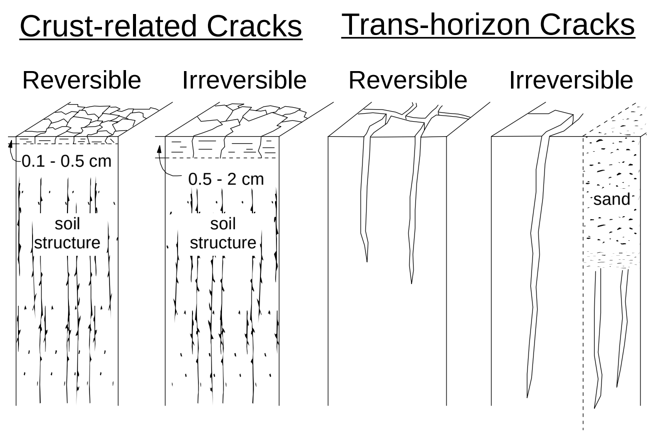
Also called "Extra-Structural Cracks" (Soil Survey Staff, 1993) are fissures other than those attributed to soil structure. Cracks are commonly vertical, sub-planar, polygonal, and are the result of desiccation, dewatering, or consolidation of earthy material. Cracks are much longer and can be much wider than planes that surround soil structural units such as prisms, columns, etc. Cracks are key to preferential flow, also called "bypass flow" (Bouma, et al., 1982) and are a primary cause of temporal (transient) changes in ponded infiltration and hydraulic conductivity in soils (Soil Survey Staff, 1993). Cracks are primarily associated with, but not restricted to, clayey soils and are most pronounced in high shrink-swell soils (high COLE value). Record the **Kind**, **Depth**, and **Relative Frequency** (Areal Percentage). A complete example is: *3, 25 cm deep, reversible trans-horizon cracks*.



CRACKS - KIND - Identify the dominant types of fissures.

Kind	Code [1]	General Description
CRUST-RELATED CRACKS [2] (shallow, vertical cracks related to crusts; derived from raindrop-splash and soil puddling, followed by dewatering / consolidation and desiccation)		
Reversible Crust-Related Cracks [3]	RCR	Very shallow (e.g., *0.1 - 0.5 cm*); very transient (generally persist less than a few weeks); formed by drying from surface down; minimal, seasonal influence on ponded infiltration (e.g., *rain-drop crust cracks*).
Irreversible Crust-Related Cracks [4]	ICR	Shallow (e.g., *0.5 - 2 cm*); seasonally transient (not present year-round nor every year); minor influence on ponded infiltration (e.g., *freeze-thaw crust & associated cracks*).
TRANS-HORIZON CRACKS [5] (deep, vertical cracks that commonly extend across more than one horizon and may extend to the surface; derived from wetting and drying or original dewatering and consolidation of parent material)		
Reversible Trans-Horizon Cracks [6]	RTH	Transient (commonly seasonal; close when rewetted); large influence on ponded infiltration and Ksat; formed by wetting and drying of soil; (e.g. *Vertisols, vertic subgroups*).
Irreversible Trans-Horizon Cracks [7]	ITH	Permanent (persist year-round; see Soil Taxonomy), large influence on ponded infiltration and Ksat (e.g., *extremely coarse subsurface fissures within glacial till; drained polder cracks*).

[1] No conventional codes, use entire term; NASIS codes are shown.
[2] Called "Surface-Initiated Cracks" (Soil Survey Staff, 1993).
[3] Called "Surface-Initiated Reversible Cracks" (Soil Survey Staff, 1993).
[4] Called "Surface-Initiated Irreversible Cracks" (Soil Survey Staff, 1993).
[5] Also called "Subsurface-Initiated Cracks" (Soil Survey Staff, 1993).
[6] Called "Subsurface-Initiated Reversible Cracks" (Soil Survey Staff, 1993).
[7] Called "Subsurface-Initiated Irreversible Cracks" (Soil Survey Staff, 1993).



CRACKS - DEPTH - Record the **Average**, **Apparent Depth** (also called a "depth index value" in the Soil Survey Manual), measured from the surface, as determined by the wire-insertion method (≅ 2 mm diameter wire). ***NOTE***: This method commonly gives a standard but conservative measure of the actual fracture depth. Do not record this data element for cracks that are not open to the surface. Depth (and apparent vertical length) of subsurface cracks can be inferred from the *Horizon Depth* column of layers exhibiting subsurface cracks.

CRACKS - RELATIVE FREQUENCY - Record the **Average Number of Cracks**, per meter, across the surface or **Lateral Frequency** across a soil profile as determined with a line-intercept method. This data element cannot be assessed from cores or push tube samples.

SPECIAL FEATURES

Record **Kind** and **Area (%) Occupied**. Describe the special soil feature by kind, and estimate the cross sectional area (%) of the horizon that the feature occupies. In PDP, three items are grouped in this data element: 1) **Special Features** - both Kind (e.g., *krotovinas* and *tongues*) and the Percent (%) of Area Covered (the area a feature occupies within a horizon); 2) **Percent of Profile** - estimate the area of the profile an individual horizon comprises; and 3) **Percent (Volume) of Pedon** occupied.

SPECIAL FEATURES - KIND - Identify the kind of special soil feature present.

Kind	Code [1]	Criteria
desert pavement	DP	A natural, concentration of closely packed and polished stones at the soil surface in a desert (may or may not be an erosional lag).
hydrophobic layer	HL	Either a surface or subsurface layer that repels water (e.g. dry organic materials; scorch layers in chaparral, etc.).
ice wedge cast	IC	A vertical, often trans-horizon, wedge-shaped or irregular form caused by infilling of a cavity as an ice wedge melts, commonly stratified.
krotovinas	KR	Filled faunal burrows.
lamellae	LL	Thin (e.g., > 1 cm), pedogenically formed plates or intermittent layers.
lamina	LN	Thin (e.g., < 1 cm), geogenically deposited strata or layers of alternating texture (e.g., silt and fine sand or silt and clay).
microbiotic crust	MC	Thin, biotically dominated ground or surface crusts; e.g., cryptogamic crust (algae, lichen, mosses, or cyanobacteria).
stone line	SL	A natural concentration of rock fragments caused by water erosoion or transport erosional lag (i.e. carpedolith).
Tongues of Albic Material	E	
Tongues of Argillic Material	B	

[1] Conventional codes consist of the entire name; e.g., *Tongues of Albic Material*. Consequently, no *Conv. code* is shown.

SPECIAL FEATURES - AREA (%) OCCUPIED - Estimate the cross sectional area (%) of the horizon that the feature occupies.

PERMEABILITY / SATURATED HYDRAULIC CONDUCTIVITY (DISCUSSION)

The traditional SCS (now NRCS) concept of soil permeability and permeability classes are becoming obsolete. The concept of permeability was originally derived from the "permeability coefficient" as used by engineers (Soil Survey Staff, 1951). Specifically, the permeability coefficient represents the ability of a porous medium to transmit fluids or gases. It is a unitless coefficient totally independent of the working fluid; e.g., water, air, hydrocarbons, molasses.

Permeability (as traditionally used by NRCS) considers only water, at field saturation, as the working fluid. This results in units of length / time; (e.g., inches / hour, cm / hr, etc.) and values that can't be extrapolated to other fluids (e.g., hydrocarbons). Furthermore, permeability (as used by NRCS) has changed through time. The original work (O'Neil, 1952) measured falling head, vertical K_{sat} for a limited number of soil cores and referred to the permeability coefficient. Over time, the term "coefficient" was dropped. Extrapolation and inference from the original, modest K_{sat} data set resulted in widespread estimations of the ability of other soils to internally transmit water. Hence, permeability is now a qualitative estimate who's "values" (i.e., classes) are inferred from soil texture or other proxies instead of actual measurements (Exhibit 618-9, NSSH; Soil Survey Staff, 1996c). It is a soil quality, as is soil tilth, which cannot be directly quantified.

A much preferred parameter (and concept) has largely replaced permeability. **Hydraulic Conductivity (K)** is the current standard for measuring a soil's ability to transmit water. Hydraulic conductivity quantifies a material's ability to transmit water. Hydraulic conductivity is a numerical variable in an equation that can be either measured or estimated. It is one of the terms in Darcy's law: $Q = K A i$, [where "Q" is outflow (volume), "K" is the hydraulic conductivity of the material, "A" is the area through which the fluid moves per unit time, and "i" is the pressure gradient (ΔHead / ΔLength); (Amoozegar and Warrick, 1986; Bouma, et al., 1982)].

Hydraulic conductivity under saturated conditions is called **Saturated Hydraulic Conductivity (K_{sat})** and is the easiest condition to assess. It is also the most common reference datum used to compare water movement in different soils, layers, or materials.

Permeability is a qualitative estimate of the relative ease with which soil transmits water. Hydraulic conductivity is a specific mathematical coefficient (quantitative) that relates the rate of water movement to the hydraulic gradient.

Direct measurement of saturated hydraulic conductivity (K_{sat}) is strongly recommended rather than an estimation of permeability inferred from other soil properties. ***NOTE***: It's highly recommended to determine the K_{sat} of a soil layer by averaging at least three determinations (≈ replications); more reps (e.g., ≥ 5) are preferred. K_{sat} is notoriously variable due to unequal distribution of soil pores and temporal changes in some soil voids (e.g., cracks, bio-pores, etc.). Replications help to capture the natural variation of K_{sat} within soils and to reduce the influence of data outliers.

NOTE: As with the virtuous child and the non-virtuous look-alike, superficial similarities are deceptive. Permeability and K_{sat} are not synonyms and should not be treated as such.

PERMEABILITY

Estimate the **Permeability Class** for each horizon. Guidelines for estimating permeability are found in Exhibit 618-9, NSSH (Soil Survey Staff, 1996c).

Permeability Class	Code PDP	Code NASIS	Criteria: estimated in / hr [1]
Impermeable	IM	IM	< 0.0015
Very Slow	VS	VS	0.0015 to < 0.06
Slow	S	SL	0.06 to < 0.2
Moderately Slow	MS	MS	0.2 to < 0.6
Moderate	M	MO	0.6 to < 2.0
Moderately Rapid	MR	MR	2.0 to < 6.0
Rapid	RA	RA	6.0 to < 20
Very Rapid	VR	VR	≥ 20

[1] These class breaks were originally defined in English units and are retained here, as no convenient metric equivalents are available.

SATURATED HYDRAULIC CONDUCTIVITY (K_{SAT})

Saturated Hydraulic Conductivity is used to convey the rate of water movement through soil under (field) saturated conditions. Record the **Average K_{sat} (X)**, **Standard Deviation (s)**, and **Number of Replications (n)** of each major layer/horizon as measured with a constant-head method (e.g., Amoozemeter, Guelph Permeameter, etc.). ***NOTE***: This data element should be measured rather than estimated and subsequently placed into classes. Estimates of water movement based on texture or other proxies must use the preceding "Permeability Class Table".

K_{sat} Class	Code [1] PDP	NASIS	Criteria [2]: cm / hr	in / hr
Very Low	1	#	< 0.0036	< 0.001417
Low	2	#	0.00360 to < 0.036	0.001417 to < 0.01417
Mod. Low	3	#	0.0360 to < 0.360	0.01417 to < 0.1417
Mod. High	4	#	0.360 to < 3.60	0.1417 to < 1.417
High	5	#	3.60 to < 36.0	1.417 to < 14.17
Very High	6	#	≥ 36.0	≥ 14.17

[1] There are no "codes" for K_{sat}; record the average of measured K_{sat} values (#) which can then be assigned to the appropriate class.

[2] For alternative units commonly used for these class boundaries [e.g., Standard International Units (Kg s / m³)], see the Soil Survey Manual (Soil Survey Staff, 1993; p 107).

CHEMICAL RESPONSE

Chemical response is the response of a soil sample to an applied chemical solution or a measured chemical value. Responses are used to identify the presence or absence of certain materials; to obtain a rough assessment of the amount present; to measure the intensity of a chemical parameter (e.g., pH.); or to gauge the "reducing" status of the soil.

REACTION (pH) - Record the pH value to the nearest tenth, as measured by pH meter for 1:1 (water:soil), or estimated by the Hellige-Truog® field kit. In PDP, record **pH** by other techniques (e.g., $CaCl_2$ or Lamotte pH) as a **User Defined Property**.

Descriptive Term	Code [1]	Criteria: pH range
Ultra Acid	#	< 3.5
Extremely Acid	#	3.5 to 4.4
Very Strongly Acid	#	4.5 to 5.0
Strongly Acid	#	5.1 to 5.5
Moderately Acid	#	5.6 to 6.0
Slightly Acid	#	6.1 to 6.5
Neutral	#	6.6 to 7.3
Slightly Alkaline	#	7.4 to 7.8
Moderately Alkaline	#	7.9 to 8.4
Strongly Alkaline	#	8.5 to 9.0
Very Strongly Alkaline	#	> 9.0

[1] No "codes"; enter the measured value; class is assigned by PDP.

EFFERVESCENCE - The gaseous response (seen as bubbles) of soil to applied HCl (carbonate test), H_2O_2 (MnO_2 test), or other chemicals. Commonly, ≈1 N HCL is used. Apply the chemical to the soil matrix (for HCL, effervescence refers only to the matrix; do not include carbonate masses, which are described as "concentrations"). Record **Effervescence Class** and **Chemical Agent**. A complete example is: *strongly effervescent with 1N-HCL* or *2, I*. In PDP, record percent of carbonate (measured with a carbonate field kit) as a **User Defined Property**.

Effervescence - Class -

Effervescence Class	Code PDP	Code NASIS	Criteria
Noneffervescent	4	NE	No bubbles form.
Very Slightly Effervescent	0	VS	Few bubbles form.
Slightly Effervescent	1	SL	Numerous bubbles form.
Strongly Effervescent	2	ST	Bubbles form a low foam.
Violently Effervescent	3	VE	Bubbles form a thick foam.

Effervescence - Location - Use locations (and codes) from **(Ped & Void) Surface Features - Location**. ***NOTE***: Application of chemicals (e.g., HCL acid) to soil matrix makes many location choices invalid.

Effervescence - Chemical Agent -

Effervescence Agent	Code PDP	Code NASIS	Criteria
HCl (unspecified) [1]	H	H1	Hydrochloric Acid: Concentration Unknown
HCl (1N) [1, 2]	I	H2	Hydrochloric Acid: Concentration = 1 Normal
HCl (3N) [1, 3]	J	H3	Hydrochloric Acid: Concentration = 3 Normal
HCl (6N) [1, 4]	---	H4	Hydrochloric Acid: Concentration = 6 Normal
H_2O_2 (unspecified) [5, 6]	P	P1	Hydrogen Peroxide: Concentration Unknown
H_2O_2 [5, 6]	O	P2	Hydrogen Peroxide: Concentration 3-4%

[1] Positive reaction indicates presence of carbonates (e.g., $CaCO_3$).
[2] Concentration of acid preferred for the effervescence field test. ***NOTE***: A (1N HCl) solution is made by combining 1 part

concentrated (37%) HCl (which is widely available) with 11 parts distilled H_2O.

[3] This concentration is not recommended for effervescence, but is required for the calcium carbonate equivalent test (CO_2 evolution, not effervescence). An approximately 3N HCl solution (actually 10% HCl or 2.87N) is made by combining 6 parts concentrated (37%) HCl (which is widely available) with 19 parts distilled H_2O.

[4] The concentration preferred for the dolomite test (effervescence by dolomitic carbonates). A 6N HCl solution is made by combining 2 parts concentrated (37%) HCl (which is widely available) with 11 parts distilled H_2O. Soil sample should be saturated in a spot plate and allowed to react for 1-2 minutes; froth = positive response. Reaction is slower and less robust than $CaCO_3$ effervescence.

[5] Positive reaction indicates presence of manganese oxides (e.g., MnO_2).

[6] Some forms of organic matter will react slowly with (3-4%) H_2O_2, whereas Mn reacts rapidly.

REDUCED CONDITIONS -

Chemical Agent	Code	Criteria
α, α '-dipyridyl [1]	P (= *positive*) N (= *negative*)	α, α '-dipyridyl conc.= 0.2%, (Childs, 1981)

[1] Positive reaction indicates presence of Fe^{+2} (i.e., reduced conditions).

SALINITY - The concentration of dissolved salts (more soluble than gypsum; e.g., NaCl) in a water extract. Estimate the **Salinity Class**. If the electrical conductivity is measured, record the actual value and the method used.

Salinity Class	Code	Criteria: (Electrical Conductivity) dS/m (mmhos/cm)
Non-Saline	0	< 2
Very Slightly Saline	1	2 to < 4
Slightly Saline	2	4 to < 8
Moderately Saline	3	8 to < 16
Strongly Saline	4	≥ 16

SODIUM ADSORPTION RATIO (SAR) - An indirect estimate of the equilibrium between soluble sodium (Na) in a salt solution and the exchangeable Na adsorbed by the soil (Soil Survey Staff, 1995). It is presented in the form of a ratio. It is used for soil solution extracts and irrigation waters to express the relative activity of sodium (Na) ions in exchange reactions with the soil. It is calculated from: SAR = $[Na^+] / \sqrt{[([Ca^{+2}] + [Mg^{+2}]) / 2]}$, where "x" is the cation concentration in millimoles per liter. As a field method, it is commonly determined with soil paste and an electronic wand.

ODOR

Record the presence of any strong smell, by horizon. No entry implies no odor.

Odor - Kind	Code	Criteria
Sulphurous	S	Presence of H_2S (hydrogen sulfide); "rotten eggs"; commonly associated with strongly reduced soil containing sulfur compounds.
Petrochemical	P	Presence of gaseous or liquid gasoline, oil, creosote, etc.

MISCELLANEOUS FIELD NOTES

Use additional adjectives, descriptors, and sketches to capture and convey pertinent information and any features for which there is no pre-existing data element or code. Record such additional information as free-hand notes under **Field Notes** ("User Defined Entries" in PDP).

MINIMUM DATA SET (for a soil description)

Purpose, field logistics, habits, and soil materials all influence the specific properties necessary to "adequately" describe a given soil. However, some soil properties or features are so universally essential for interpretations or behavior prediction that they should always be recorded. These include: **Location**, **Horizon**, **Horizon Depth**, **Horizon Boundary**, **Color**, **Redoximorphic Features**, **Texture**, **Structure**, and **Consistence**.

PROFILE DESCRIPTION FORM

[To be developed.]

PROFILE DESCRIPTION EXAMPLE

[To be developed.]

PROFILE DESCRIPTION REPORT EXAMPLE (for Soil Survey Reports)

[To be developed.]

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GEOMORPHIC DESCRIPTION SYSTEM
(Version 2.06 - 9/4/97)

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PART I: PHYSIOGRAPHIC LOCATION
- A) Physiographic Division
- B) Physiographic Province
- C) Physiographic Section
- D) State Physiographic Area
- E) Local Physiographic / Geographic Name

PART II: GEOMORPHIC DESCRIPTION
- A) Landscape
- B) Landform
- C) Microfeature
- D) Anthropogenic Features

PART III: SURFACE MORPHOMETRY
- A) Elevation
- B) Slope Aspect
- C) Slope Gradient
- D) Slope Complexity
- E) Slope Shape
- F) Hillslope - Profile Position
- G) Geomorphic Component
  1. Hills
  2. Terraces
  3. Mountains
  4. Flat Plains (Proposed)
- H) Microrelief

NOTE: Italicized NASIS short-codes, if available, follow each choice.

PART I: PHYSIOGRAPHIC LOCATION

Reference: **A**, **B**, & **C** see Fenneman's 1946 map (reprinted 1957), and Wahrhaftig, 1965.

Physiographic Divisions (A)		**Physiographic Provinces (B)** / **Physiographic Sections (C)**	
Laurentian Upland	*LU*	1. Superior Upland	*SU*
Atlantic Lowland	*AL*	2. Continental Shelf	*CS*
		3. Coastal Plain	*CP*
		a. Embayed section	*EMS*
		b. Sea Island section	*SIS*
		c. Floridian section	*FLS*
		d. East Gulf Coastal plain	*EGC*
		e. Mississippi alluvial valley	*MAV*
		f. West Gulf Coastal plain	*WGC*
Appalachian Highlands	*AH*	4. Piedmont Province	*PP*
		a. Piedmont upland	*PIU*
		b. Piedmont lowlands	*PIL*
		5. Blue Ridge Province	*BR*
		a. Northern section	*NOS*
		b. Southern section	*SOS*
		6. Valley and Ridge Province	*VR*
		a. Tennessee section	*TNS*
		b. Middle section	*MIS*
		c. Hudson Valley	*HUV*
		7. St. Lawrence Valley	*SL*
		a. Champlain section	*CHS*
		b. St. Lawrence Valley, - northern section	*NRS*
		8. Appalachian Plateau	*AP*
		a. Mohawk section	*MOS*
		b. Catskill section	*CAS*
		c. Southern New York sect.	*SNY*
		d. Allegheny Mountain sect.	*AMS*
		e. Kanawaha section	*KAS*

		f. Cumberland Plateau sect.	*CPS*
		g. Cumberland Mountain sect.	*CMS*
		9. New England Province	*NE*
		a. Seaboard lowland sect.	*SLS*
		b. New England upland sect.	*NEU*
		c. White Mountain section	*WMS*
		d. Green Mountain section	*GMS*
		e. Taconic section	*TAS*
		10. Adirondack Province	*AD*
Interior Plains	*IN*	11. Interior Low Plateaus	*IL*
		a. Highland rim section	*HRS*
		b. Lexington lowland	*LEL*
		c. Nashville basin	*NAB*
		d. Possible western section (not delimited on map)	*WES*
		12. Central Lowland Province	*CL*
		a. Eastern lake section	*ELS*
		b. Western lake section	*WLS*
		c. Wisconsin driftless section	*WDS*
		d. Till plains	*TIP*
		e. Dissected till plains	*DTP*
		f. Osage plain	*OSP*
		13. Great Plains Province	*GP*
		a. Missouri plateau, glaciated	*MPG*
		b. Missouri plateau, unglaciated	MPU
		c. Black Hills	*BLH*
		d. High Plains	*HIP*
		e. Plains Border	*PLB*
		f. Colorado Piedmont	*COP*
		g. Raton section	*RAS*
		h. Pecos valley	*PEV*
		i. Edwards Plateau	*EDP*
		k. Central Texas section	*CTS*

This division includes portions of Alaska
(see “Alaskan Physiographic Areas”)

Interior Highlands	*IH*	14. Ozark Plateau	*OP*
		a. Springfield-Salem plateaus	*SSP*
		b. Boston “Mountains”	*BOM*

		15. Ouachita Province	*OU*
		a. Arkansas Valley	*ARV*
		b. Ouachita Mountains	*OUM*
Rocky Mountain System	*RM*	16. Southern Rocky Mountains	*SR*
		17. Wyoming Basin	*WB*
		18. Middle Rocky Mountains	*MR*
		19. Northern Rocky Mountains	*NR*

This division includes portions of Alaska (see "Alaskan Physiographic Areas")

Intermontane Plateaus	*IP*	20. Columbia Plateau	*CR*
		a. Walla Walla Plateau	*WWP*
		b. Blue Mountain section	*BMS*
		c. Payette section	*PAS*
		d. Snake River Plain	*SRP*
		e. Harney section	*HAS*
		21. Colorado Plateau	*CO*
		a. High Plateaus of Utah	*HPU*
		b. Uinta Basin	*UIB*
		c. Canyon Lands	*CAL*
		d. Navajo section	*NAS*
		e. Grand Canyon section	*GCS*
		f. Datil section	*DAS*
		22. Basin and Range Province	*BP*
		a. Great Basin	*GRB*
		b. Sonoran Desert	*SOD*
		c. Salton Trough	*SAT*
		d. Mexican Highland	*MEH*
		e. Sacramento section	*SAS*

This division includes portions of Alaska (see "Alaskan Physiographic Areas")

Pacific Mountain	*PM*	23. Cascade-Sierra Mountains	*CM*
		a. Northern Cascade Mtns.	*NCM*
		b. Middle Cascade Mtns.	*MCM*
		c. Southern Cascade Mtns.	*SCM*
		d. Sierra Nevada	*SIN*

24. Pacific Border Province	*PB*
a. Puget Trough	*PUT*
b. Olympic Mountains	*OLM*
c. Oregon Coast Range	*OCR*
d. Klamath Mountains	*KLM*
e. California Trough	*CAT*
f. California Coast Ranges	*CCR*
g. Los Angeles Ranges	*LAR*
25. Lower California Province	*LC*

This division includes portions of Alaska
(see "Alaskan Physiographic Areas")

Alaskan Physiographic Areas (Warhaftig, 1965)

The following Alaskan-Peninsula physiographic areas are extensions of the previous North American Physiographic Divisions (e.g., Rocky Mountain System). These extensions are presented separately, rather than intermingled with the previous Division / Province lists because they:
a) constitute a geographically coherent package (Wahrhaftig, 1965);
b) these extensions were not contained within Fennman's original work which dealt only with the conterminous U.S. (Fenneman, 1931; 1938; & 1946); and c) Wahrhaftig's map-unit numbers are independent of, and inconsistent with Fenneman's. Wahrhaftig's original map unit scheme and numbers are retained here for simplicity in using his map of the Alaskan peninsula. ***CAUTION***: Wahrhaftig's map unit numbers should not be confused with similar map unit numbers from Fenneman's map for the conterminous U.S.

Interior Plains	*IN*	1. Arctic Coastal Plain Province	--
		a. Teshekpuk Hills section	--
		b. White Hills section	--
		2. Arctic Foothills Province	*AF*
		a. Northern Section	--
		b. Southern Section	--
Rocky Mountains System	*RM*	Arctic Mountains Province	*AM*
		3. Delong Mountains section	--
		4. Noatak Lowlands section	--
		5. Baird Mountains section	--
		6. Central & E. Brooks Range sect.	--
		7. Ambler-Chandalar Ridge & Lowland sect.	--

NOTE: The map-unit numbering sequence shown here is from Wahrhaftig (1965), and is independent of, and not consistent with, that of Fenneman.

Intermontane Plateaus	Northern Plateaus Province	--
IP	8. Porcupine Plateau section	--
	a. Thazzik Mountain	
	9. Old Crow Plain section	--
	(noted but not described)	
	10. Olgivie Mountains section	--
	11. Tintina Valley (Eagle Trough) sect.	--
	12. Yukon-Tanana Upland section	--
	a. Western Part	
	b. Eastern Part	
	13. Northway - Tanacross Lowland sect.	--
	14. Yukon Flats section	--
	15. Rampart Trough section	--
	16. Kokrine - Hodzana Highlands sect.	--
	a. Ray Mountains	
	b. Kokrine Mountains	
	Western Alaska Province	--
	17. Kanuti Flats section	--
	18. Tozitna - Melozitna Lowland sect.	--
	19. Indian River Upland section	--
	20. Pah River Section	--
	a. Lockwood Hills	
	b. Pah River Flats	
	c. Zane Hills	
	d. Purcell Mountains	
	21. Koyukuk Flats section	--
	22. Kobuk-Selawik Lowland section	--
	a. Waring Mountains	
	23. Selawik Hills section	--
	24. Buckland River Lowland section	--
	25. Nulato Hills section	--
	26. Tanana - Kuskowin Lowland sect.	--
	27. Nowitna Lowland section	--
	28. Kuskokwim Mountains section	--
	29. Innoko Lowlands section	--
	30. Nushagak - Big River Hills section	--
	31. Holitna Lowland section	--
	32. Nushagak-Bristol Bay Lowlnd sect.	--
	33. Seward Peninsula Province	*SEP*
	a. Bendeleben Mountains	
	b. Kigluaik Mountains	
	c. York Mountains	

		Bering Shelf Province	*BES*
		34. Yukon- Kuskokwim Coastal Lowland sect.	--
		a. Norton Bay Lowland	
		35. Bering Platform section	--
		a. St. Lawrence Island	
		b. Pribilof Island	
		c. St. Matthew Island	
		d. Nunivak Island	
		36. Ahklun Mountains Province	---

NOTE: The map-unit numbering sequence shown here is from Wahrhaftig (1965), and is independent of, and not consistent with, that of Fenneman.

Pacific Mountian System	*PM*	Alaska - Aleutian Province	*AAC*
		37. Aleutian Islands section	--
		38. Aleutian Range section	--
		39. Alaska Range (Southern Part) sect.	--
		40. Alaska Range (Central & Eastern Parts) section	--
		a. Mentasta - Nutzotin Mtn. segment	
		41. Northern Foothills of the Alaska Range section	--
		Coastal Trough Province	--
		42. Cook Inlet - Susitna Lowland sect.	--
		43. Broad Pass Depression section	--
		44. Talkeetna Mountains section	--
		a. Chulitna Mountains	
		b. Fog Lakes Upland	
		c. Central Talkeetna Mountains	
		d. Clarence Lake Upland	
		e. Southeastern Talkeetna Mountains	
		45. Upper Matanuska Valley section	--
		46. Clearwater Mountains section	--
		47. Gulkana Upland section	--
		48. Copper River Lowland section	--
		a. Eastern Part	
		b. Western Part: Lake Louis Plateau	
		49. Wrangell Mountains section	--
		50. Duke Depression (not described)	
		51. Chatham Trough section	--
		52. Kupreanof Lowland section	--
		Pacific Border Ranges Province	*PBS*
		53. Kodiak Mountains section	--

		54. Kenai - Chugach Mountains sect.	--
		55. St Elias Mountains section	--
		a. Fairweather Range subsection	
		56. Gulf of Alaska Coastal section	--
		57. Chilkat - Baranof Mountains sect.	--
		a. Alsek Ranges subsection	
		b. Glacier Bay subsection	
		c. Chichagof Highland subsection	
		d. Baranof Mountains subsection	
		58. Prince of Whales Mountains sect.	--
		Coast Mountains Province	*COM*
		59. Boundary Pass section	--
		60. Coastal Foothills section	--

Other Physiographic Areas
(not addressed by Fenneman, 1946; or Wahrhaftig, 1965)

Pacific Rim	*PR*	Pacific Islands Province	*PI*
		a. Hawaiian Islands	*HAI*
		b. Guam	*GUM*
		c. Trust territories *	*TRT*
		d. other (?)	

* Most of the former U.S. Trust Territories of the Pacific are now independent nations. This designation is used here soley for brevity and to aid in accessing archived, historical data.

Caribbean Basin	*CB*	Caribbean Islands Province	*CI*
		a. Greater Antilles (Puerto Rico)	*GRA*
		b. Lesser Antilles (U.S. Virgin Is.)	*LEA*
		c. other (?)	
Undesignated	*UN*	Other	*OT*

(reserved for temporary, or international designations)

State Physiographic Area (E)

(OPTIONAL) (Entries presently undefined; to be developed in conjunction with each State Geological Survey; target scale is approximately 1:100,000.)

Local Physiographic / Geographic Name (F)

(OPTIONAL) (Entries presently undefined; to be developed in conjunction with each State

Geological Survey; may include area names found on USGS 7.5 & 15 minute topographic maps; target scale is approximately 1:24,000.)

Sources:

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PART II: GEOMORPHIC DESCRIPTION (OUTLINE)

A) Landscape Terms

B) Landform Terms

- i) Alphabetical List (comprehensive, master list)
- ii) Landform Subset Lists (landform terms grouped by “process” or common setting)

    1. Beach, Coastal, Marine, and Lacustrine Landforms
    2. Depressional Landforms
    3. Eolian Landforms
    4. Erosional Landforms
    5. Fluvial Landforms
    6. Glacial Landforms
    7. Mass Movement Landforms
    8. Periglacial Landforms
    9. Solution Landforms
    10. Slope Landforms
    11. Tectonic, Structural, and Volcanic Landforms
    12. Wetland Terms and Landforms
    13. Water “Landforms” and Related Terms

C) Microfeature Terms

D) Anthropgenic Terms

NOTE: Italicized NASIS short-codes, if available, follow each choice.

PART II: GEOMORPHIC DESCRIPTION

A) Landscape
(LF = Landform)

badlands	*BA*	marine terrace (also LF)	--
bajada (also LF)	*BJ*	meander belt	*MB*
basin	*BS*	mountains (singular = LF)	*MO*
bolson	*BO*	piedmont	*PI*
breaks	*BK*	plains (also LF)	*PL*
canyonlands	--	plateau (also LF)	*PT*
coastal plain (also LF)	*CP*	river valley	*RV*
delta plain (also LF)	--	sandhills	*SH*
drumlin field	--	sand plain	--
dune field	--	scabland	*SC*
fan piedmont (also LF)	*FP*	semi-bolson	*SB*
foothills	*FH*	shore complex	--
hills (singular = LF)	*HI*	tableland	*TB*
intermontane basin (also LF)	*IB*	thermokarst	*TK*
island (also LF)	--	till plain (also LF)	*TP*
karstland	*KP*	upland	*UP*
lava plateau (also LF)	*LL*	valley (also LF)	*VA*

B) Landform
(LS = Landscape; micro = microfeature; w = water body. Italicized NASIS code follows each term.)

i) Alphabetical Landform List

a'a lava flow	--	ballon	*BV*
alas	*AA*	bar	*BR*
alluvial fan	*AF*	barchan dune	*BQ*
alluvial flat	*AP*	barrier beach	*BB*
anticline	*AN*	barrier flat	*BP*
arete	*AR*	barrier island	*BI*
arroyo	*AY*	basin floor	*BC*
ash flow (also material)	*AS*	basin-floor remnant	*BD*
atoll	*AT*	bay (w)	*WB*
avalanche chute	*AL*	bayou (w)	*WC*
backshore	*AZ*	beach	*BE*
backswamp	*BS*	beach plain	*BP*
bajada (also LS)	*BJ*	beach ridge	*BG*
ballena	*BL*	beach terrace	*BT*

berm	BM
blind valley	VB
block field (also material)	BW
block glide (also material)	--
block stream (also material)	BX
blowout	BY
bluff	BN
bog (also wetland)	BO
braided stream	BZ
butte	BU
caldera	CD
canyon	CA
Carolina Bay	CB
channel (also micro)	CC
chenier	CG
chenier plain	CH
cinder cone	CI
cirque	CQ
cliff	CJ
coastal plain (also LS)	CP
col	CL
collapsed ice-floored lakebed	CK
collapsed ice-walled lakebed	CN
collapsed lake plain	CS
collapsed outwash plain	CT
complex landslide	--
coulee	CE
cove	CO
crater (volcanic)	CR
crevasse filling	CF
cuesta	CU
cutoff	CV
debris avalanche (also material)	DA
debris flow (also material)	DF
debris slide (also material)	--
deflation basin	DB
delta	DE
delta plain (also LS)	DC
depression	DP
diapir	DD
dike	DK
dipslope	DL
disintegration moraine	DM
divide	DN
dome	DO

drainageway	DQ
draw	DW
drumlin	DR
dune	DU
earth flow (also material)	EF
end moraine	EM
ephemeral stream (also micro)	--
erosion remnant	ER
escarpment	ES
esker	EK
estuary (w)	WD
faceted spur	FS
fall (also material)	FB
fan	FC
fan apron	FA
fanhead trench	FF
fan piedmont (also LS)	FG
fan remnant	FH
fan skirt	FI
fault-line scarp	FK
fen	FN
fjord (w)	FJ
flat	FL
flood plain	FP
flood-plain playa	FY
flood-plain splay	FM
flood-plain step	FO
flute	FU
fold (also structure)	FQ
foredune	FD
fosse	FV
free face	FW
gap	GA
giant ripple	GC
glacial drainage channel	GD
glacial lake (w)	WE
glacial lake (relict)	GL
gorge	GO
graben	GR
ground moraine	GM
gulch	GT
gut (channel); (w)	WH
gut (valley)	GV
hanging valley	HV
headland	HE

headwall	*HW*	meander	*MB*
highmoor bog	*HB*	meandering channel	*MC*
hill	*HI*	meander scar	*MS*
hogback	*HO*	meander scroll	*MG*
horn	*HR*	medial moraine	*MH*
horst	*HT*	mesa	*ME*
inselberg	*IN*	monadnock	*MD*
inset fan	*IF*	monocline (also structure)	*MJ*
interdune	*ID*	moraine	*MU*
interfluve (also Geom. Component - Hills)	*IV*	mountain (also LS)	*MM*
intermittent stream (also micro)	--	mountain slope	*MN*
intermontane basin (also LS)	*IB*	mountain valley	*MV*
island (also LS)	--	mud flat	*MF*
kame	*KA*	mudflow (also material)	*MW*
kame moraine	*KM*	muskeg	*MX*
kame terrace	*KT*	natural levee	*NL*
kettle	*KE*	notch	*NO*
kipuka	--	nunatak	*NU*
knob	*KN*	outwash fan	*OF*
knoll	*KL*	outwash plain	*OP*
lagoon (w)	*WI*	outwash terrace	*OT*
lahar (also material)	*LA*	overflow stream (channel)	--
lake (w)	*WJ*	oxbow	*OX*
lakebed (relict)	*LB*	oxbow lake (w)	*WK*
lake plain	*LP*	oxbow lake (ephemeral)	*OL*
lakeshore	*LF*	paha	*PA*
lake terrace	*LT*	pahoehoe lava flow	--
landslide (also material)	*LK*	paleoterrace (or relict terrace)	--
lateral moraine	*LM*	parabolic dune	*PB*
lateral spread (also material)	--	parna dune	*PD*
lava flow	*LC*	partial ballena	*PF*
lava plain	*LN*	patterned ground	*PG*
lava plateau (also LS)	*LL*	peak	*PK*
lava tube	--	peat plateau	*PJ*
ledge	*LE*	pediment	*PE*
levee (stream)	*LV*	perennial stream (w)	--
loess bluff	*LO*	pingo	*PI*
loess hill	*LQ*	pitted outwash plain	*PM*
longshore bar [relict]	*LR*	pitted outwash terrace	--
louderback (also structure)	*LU*	plain (also LS)	*PN*
lowmoor bog	*LX*	plateau (also LS)	*PT*
marine terrace	*MT*	playa	*PL*
marsh	*MA*	playa lake (w)	*WL*
mawae	--	plug dome	*PP*
		pluvial lake (w)	*WM*
		pluvial lake (relict)	*PQ*

pocosin	*PO*
point bar	*PR*
pothole (also micro)	*PH*
pothole lake (w)	*WN*
pressure ridge (volc)	*PU*
proglacial lake (w)	*WO*
proglacial lake (relict)	--
raised beach	*RA*
raised bog	*RB*
ravine	*RV*
recessional moraine	*RM*
reef	*RF*
ribbed fen	*RG*
ridge	*RI*
rim	*RJ*
rise	--
river (w)	--
roche mountonnee	*RN*
rock fall (also micro)	--
rock avalanche (also material)	--
rock glacier	*RO*
rotational landslide (also material)	*RP*
saddle	*SA*
salt marsh	*SM*
salt pond (w)	*WQ*
sand flow (also material)	*RW*
sand sheet	*RX*
scarp	*RY*
scarp slope	*RS*
scree slope	--
sea cliff	*RZ*
seif dune	*SD*
shield volcano	--
shoal (w)	*WR*
shoal (relict)	*SE*
shore	--
shrub-coppice dune (micro)	*SG*
sill	*RT*
sinkhole	*SH*
slackwater (w)	*WS*
slide (also material)	*SJ*
slough (ephemeral water)	*SL*
slough (permanent water)	*WU*
slump	*SK*
slump block	*SN*
soil fall	--
spit	*SP*
spur	*SQ*
stack	*SR*
steptoe	*ST*
strand plain	*SS*
strath terrace	*SU*
stratovolcano	*SV*
stream (w)	--
stream terrace	*SX*
string bog	*SY*
structural bench	*SB*
swale (also micro)	*SC*
swallow hole	*TB*
swamp	*SW*
syncline (also structure)	*SZ*
talus slope	--
terminal moraine	*TA*
terrace	*TE*
thermokarst depression	*TK*
thermokarst lake (w)	*WV*
tidal flat	*TF*
till plain (also LS)	*TP*
tombolo	*TO*
topple	--
tor	*TQ*
translational slide	*TS*
transverse dune	*TD*
trough	*TR*
tunnel valley	*TV*
U-shaped valley	*UV*
valley	*VA*
valley flat	*VF*
valley floor	*VL*
valley side	*VS*
valley train	*VT*
volcanic cone	*VC*
volcanic dome	*VD*
volcano	*VO*
V-shaped valley	*VV*
wash	*WA*
washover fan	*WF*
wave-built terrace	*WT*
wave-cut platform	*WP*
wind gap	*WG*
yardang (also micro)	--

yardang trough (also micro) --

ii) Landform Subset Lists (Landform terms grouped by "process" or common setting)

1. Beach, Coastal, Marine, and Lacustrine Landforms

atoll	*AT*	lakebed (relict)	*LB*
backshore	*AZ*	lake plain	*LP*
bar	*BR*	lake terrace	*LT*
barrier beach	*BB*	longshore bar [relict]	*LR*
barrier flat	*BF*	marine terrace (also LS)	*MT*
barrier island	*BI*	mud flat	*MF*
beach	*BE*	playa	*PL*
beach plain	*BP*	pluvial lake (relict)	*PQ*
beach ridge	*BG*	raised beach	*RA*
beach terrace	*BT*	reef	*RF*
berm	*BM*	salt marsh	*SM*
bluff	*BN*	sea cliff	*RZ*
chenier	*CG*	shoal (relict)	*SE*
chenier plain	*CH*	shore	--
coastal plain	*CP*	spit	*SP*
delta	*DE*	stack	*SR*
delta plain (also LS)	*DC*	strand plain	*SS*
flat	*FL*	tidal flat	*TF*
foredune	*FD*	tombolo	*TO*
headland	*HE*	washover fan	*WF*
island (also LS)	--	wave-built terrace	*WT*
lagoon	*WI*	wave-cut platform	*WP*

2. Depressional Landforms

alluvial flat	*AP*	gulch	*GT*
basin floor	*BC*	gut (valley)	*GV*
basin floor remnant	*BD*	interdune	*ID*
canyon	*CA*	intermontane basin	*IB*
Carolina Bay	*CB*	kettle	*KE*
col	*CL*	mountain valley	*MV*
coulee	*CE*	playa	*PL*
cove	*CO*	pothole (also micro)	*PH*
depression	*DP*	ravine	*RV*
drainageway	*DQ*	saddle	*SA*
gap	*GA*	slough (ephemeral)	*SL*
gorge	*GO*	swale (also micro)	*SC*

trough	*TR*	valley floor	*VL*
U-shaped valley	*UV*	V-shaped valley	*VV*
valley	*VA*		

3. Eolian Landforms

barchan dune	*BQ*	loess hill	*LQ*
blowout	*BY*	paha	*PA*
deflation basin	*DB*	parabolic dune	*PB*
dune	*DU*	parna dune	*PD*
foredune	*FD*	sand sheet	*RX*
interdune	*ID*	seif dune	*SD*
loess bluff	*LO*	transverse dune	*TD*

4. Erosional Landforms - Water erosion (overland flow) related and excluding fluvial, glaciofluvial, and eolian erosion.

arete	*AR*	monadnock	*MD*
ballena	*BL*	notch	*NO*
ballon	*BV*	paha	*PA*
basin floor remnant	*BD*	partial ballena	*PF*
col	*CL*	peak	*PK*
cuesta	*CU*	pediment	*PE*
erosion remnant	*ER*	saddle	*SA*
free face	*FW*	scarp slope	*RS*
gap	*GA*	strath terrace	*SU*
hogback	*HO*	structural bench	*SB*
horn	*HR*	tor	*TQ*
inselberg	*IN*	wind gap	*WG*
meander scar	*MS*		

5. Fluvial Landforms - Dominantly related to concentrated water (channel flow), both erosional and depositional processes, and excluding glaciofluvial landforms.

alluvial fan	*AF*	braided stream	*BZ*
alluvial flat	*AP*	canyon	*CA*
arroyo	*AY*	channel	*CC*
backswamp	*BS*	coulee	*CE*
bajada	*BJ*	cutoff	*CV*
bar	*BR*	delta	*DE*
basin-floor remnant	*BD*	delta plain (also LS)	*DC*
block stream	*BX*	drainageway	*DQ*

draw	*DW*	meander scar	*MS*
fanhead trench	*FF*	meander scroll	*MG*
fan skirt	*FI*	natural levee	*NL*
flood plain	*FP*	overflow stream (channel)	--
flood-plain playa	*FY*	oxbow	*OX*
flood-plain splay	*FM*	oxbow lake (ephemeral)	*OL*
flood-plain step	*FO*	pediment	*PE*
giant ripple	*GC*	point bar	*PR*
gorge	*GO*	ravine	*RV*
gulch	*GT*	strath terrace	*SU*
gut (valley)	*GV*	stream terrace	*SX*
inset fan	*IF*	wash	*WA*
levee (stream)	*LV*	wind gap	*WG*

6. Glacial Landforms (including glaciofluvial forms)

arete	*AR*	kame moraine	*KM*
cirque	*CQ*	kame terrace	*KT*
col	*CL*	kettle	*KE*
collapsed ice-floored lakebed	*CK*	lateral moraine	*LM*
		medial moraine	*MH*
collapsed ice-walled lakebed	*CN*	moraine	*MU*
		nunatak	*NU*
collapsed lake plain	*CS*	outwash fan	*OF*
collapsed outwash plain	*CT*	outwash plain	*OP*
crevasse filling	*CF*	outwash terrace	*OT*
disintegration moraine	*DM*	paha	*PA*
drumlin	*DR*	pitted outwash plain	*PM*
end moraine	*EM*	pitted outwash terrace	--
esker	*EK*	pressure ridge (ice)	--
fjord (w)	*FJ*	proglacial lake (relict)	--
flute	*FU*	recessional moraine	*RM*
fosse	*FV*	roche mountonnee	*RN*
giant ripple	*GC*	rock glacier	*RO*
glacial drainage channel	*GD*	terminal moraine	*TA*
glacial lake (relict)	*GL*	till plain (also LS)	*TP*
ground moraine	*GM*	tunnel valley	*TV*
hanging valley	*HV*	U - shaped valley	*UV*
kame	*KA*		

7. Mass Movement Landforms (including creep forms)

ash flow	*AS*	rock fall (also micro)	--
avalanche chute	*AL*	rockfall avalanche	--
block glide	--	rock glacier	*RO*
complex slide	--	rotational landslide	*RP*
debris avalanche	--	sand flow	*RW*
debris flow	*DF*	slide	*SJ*
debris slide	--	slump	*SK*
earth flow	*EF*	slump block	*SN*
fall	*FB*	soil fall	--
lahar	*LA*	talus	--
landslide	*LK*	topple	--
lateral spread	--	translational slide	*TS*
mudflow	*MW*		

8. Periglacial Landforms (modern, relict, and patterned ground)

alas	*AA*	peat plateau	*PJ*
block field	*BW*	pingo	*PI*
muskeg	*MX*	rock glacier	*RO*
patterned ground (see Microfeatures)	*PG*	string bog	*SY*
		thermokarst depression	*TK*

9. Solution Landforms

blind valley	*VB*	swallow hole	*TB*
sinkhole	*SH*	thermokarst depression	*TK*

10. Slope Landforms - Terms that tend to be generic and that emphasize their form rather than any particular genesis or process.

bluff	*BN*	headwall	*HW*
butte	*BU*	hill (plural = LS)	*HI*
cliff	*CJ*	hogback	*HO*
cuesta	*CU*	horn	*HR*
dome	*DO*	horst	*HT*
escarpment	*ES*	inselberg	*IN*
faceted spur	*FS*	interfluve (also Geom. Component - Hills)	*IV*
fault-line scarp	*FK*	knob	*KN*
free face	*FW*		
gap	*GA*	knoll	*KL*

lahar	*LA*	plain (also LS)	*PN*
ledge	*LE*	plateau (also LS)	*PT*
meander scar	*MS*	ridge	*RI*
mesa	*ME*	rim	*RJ*
monadnock	*MD*	scarp	*RY*
mountain	*MM*	spur	*SQ*
mountain slope	*MN*	structural bench	*SB*
mountain valley	*MV*	tor	*TQ*
notch	*NO*	U - shaped valley	*UV*
paha	*PA*	V - shaped valley	*VV*
peak	*PK*	wind gap	*WG*

11. Tectonic, Structural, and Volcanic Landforms

a'a lava flow	--	lava plain	*LN*
anticline	*AN*	lava plateau (also LS)	*LL*
caldera	*CD*	lava tube	--
cinder cone	*CI*	louderback	*LU*
crater (volcanic)	*CR*	mawae	--
cuesta	*CU*	monocline	*MJ*
diapir	*DD*	pahoehoe lava flow	--
dike	*DK*	plug dome	*PP*
dipslope	*DL*	pressure ridge (volcanic)	*PU*
dome	*DO*	scarp slope	*RS*
fault-line scarp	*FK*	shield volcano	--
graben	*GR*	steptoe	*ST*
hogback	*HO*	stratovolcano	*SV*
horst	*HT*	structural bench	*SB*
kipuka	--	syncline (also structure)	*SZ*
lahar	*LA*	volcanic cone	*VC*
lava flow	*LC*	volcanic dome	*VD*

12. Wetland Terms and Landforms (provisional list: conventional, geologic definitions; not legalistic or regulatory usage)

alas	*AA*	marsh	*MA*
backswamp	*BS*	mud flat	*MF*
bog	*BO*	muskeg	*MX*
Carolina Bay	*CB*	oxbow lake (ephemeral)	*OL*
estuary	*WD*	peat plateau	*PJ*
fen	*FN*	playa (intermittent water)	*PL*
highmoor bog	*HB*	pocosin	*PO*
lowmoor bog	*LX*	pothole (intermittent water)	*PH*

raised bog	*RB*	string bog	*SY*
ribbed fen	*RG*	swamp	*SW*
salt marsh	*SM*	tidal flat	*TF*
slough (intermittent water)	*SL*		

13. Water "Landforms" and Related Terms - Discrete landform terms but treated generically as "water" in soil survey.

bay	*WB*	playa lake	*WL*
bayou	*WC*	pluvial lake	*WM*
ephemeral stream (also micro)	--	pond (micro)	--
		pool (micro)	--
estuary	*WD*	pothole (lake)	*WN*
fjord	*FJ*	proglacial lake	*WO*
glacial lake	*WE*	river (w)	--
gut (channel)	*WH*	salt pond	*WQ*
intermittent stream		shoal	*WR*
(also micro)	--	slackwater	*WS*
lagoon	*WI*	slough (permanent water)	*WU*
lake	*WJ*	stream (w)	--
oxbow lake	*WK*	tank (micro)	--
perennial stream		thermokarst lake	*WV*
(w; also micro)	--		

C) Microfeature Terms

bar	--	hoodoo	--
channel (also LF)	--	mound	*M:*
earth pillar	--	*patterned ground* microfeatures (see below; used in association with the landform "*patterned ground* (*PG*)")	
frost boil	--		
groove	--		
gullies	--		
hillock	--		

a) Periglacial *patterned ground* microfeatures:

circle	--	polygons	--
earth hummocks	--	sorted circles	--
high-center polygons	--	stripes	--
ice wedge polygons	--	turf hummocks	--
low-center polygons	--		
non-sorted circles	--		
palsa, palsen (= peat hummocks)	--		

b) Other *patterned ground* microfeatures:

bar and channel	--	mima mounds	--
gilgai	*G*	pimple mounds	--
hummocks	--		

pinnacle	--	solifluction sheet	--
pond (also water list)	--	solifluction terrace	--
pool (also water list)	--	swale (also LF)	--
pothole (also LF)	--	tank (also water list)	--
rib	--	terracettes	T
ripple mark	--	tree-tip mound	--
sand boil	--	tree-tip pit	--
scour (mark)	--	yardang (also LF)	--
solifluction lobe	--	yardang trough (also LF)	--

D) Anthropogenic Features

artificial collapsed depression (e.g., arising from subsurface mining subsidence)	*G*	quarry	--
artificial levees	*A*	railroad bed	*D*
? barrow pit	--	? reclaimed land	--
burial mound	*B*	rice paddy	*E*
? cuts (road, railroad)	--	? rill	--
? drainage ditch	--	road bed	*I*
? fills	--	sand pit	--
gravel pit	--	? scalped areas	--
landfill	--	sewage lagoon	--
? levelled land	--	spoil bank	--
midden	*H*	surface mine (pit?)	--
pond (human-made)	--	*tillage / management features* (see below for common, more specific types)	*F*

a) *Tillage / management features* (common types):

conservation terrace (modern)	--	drainage ditch	--
double-bedding mound (i.e., bedding mound used for timber; lower Coastal Plain)	--	furrows	--
		hillslope terrace (e.g., archeological features; China, Peru)	--
		inter-furrow	--

? urban land --

NOTE: Italicized NASIS short-codes, if available, follow each choice.

PART III: SURFACE MORPHOMETRY

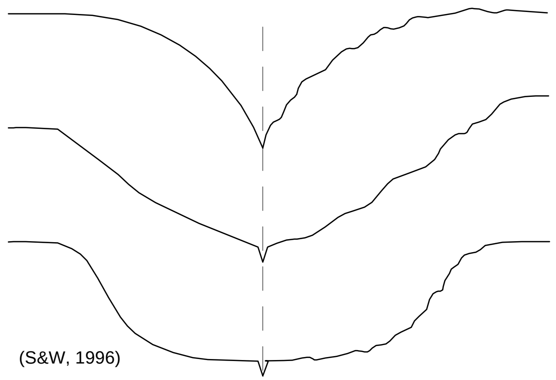
A) **Elevation**: The height of a point on the earth's surface, relative to mean sea level (msl); indicate units; e.g., *106 m* or *348 ft*.

B) **Slope Aspect**: The compass bearing (in degrees, corrected for declination) that a slope faces, looking downslope.

C) **Slope Gradient**: The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. (Commonly referred to as slope.)

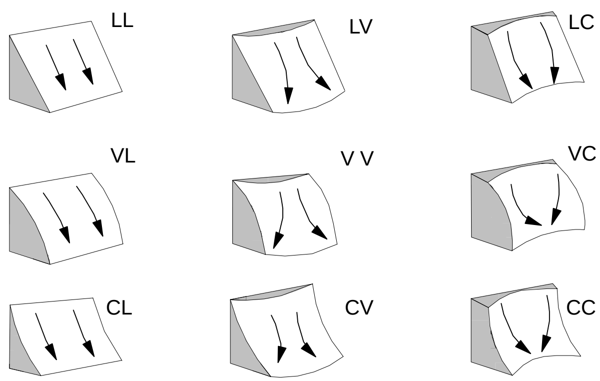
D) **Slope Complexity**: Describe the relative uniformity (smooth linear or curvilinear = *simple* or *S*) or irregularity (*complex* or *C*) of the ground surface leading downslope through the point of interest; e.g., s*imple* or *S*.

Simple vs. Complex



E) **Slope Shape**: Slope shape is described in two directions: 1) up and down slope (perpendicular (normal) to the contour); and 2) across slope (along the horizontal contour). In PDP, this data element is split into two sequential parts (Slope Across and Slope Up & Down); e.g., *Linear, Convex LV*.

Down Slope (Vertical)	Across Slope (Horizontal)	Codes	
		PDP3.5	**NASIS**
Concave	Concave	*CC, CC*	*CC*
Concave	Convex	*CC, CV*	*CV*
Concave	Linear	*CC, LL*	*CL*
Convex	Concave	*CV, CC*	*VC*
Convex	Convex	*CV, CV*	*VV*
Convex	Linear	*CV, LL*	*VL*
Linear	Concave	*LL, CC*	*LC*
Linear	Convex	*LL, CV*	*LV*
Linear	Linear	*LL, LL*	*LL*



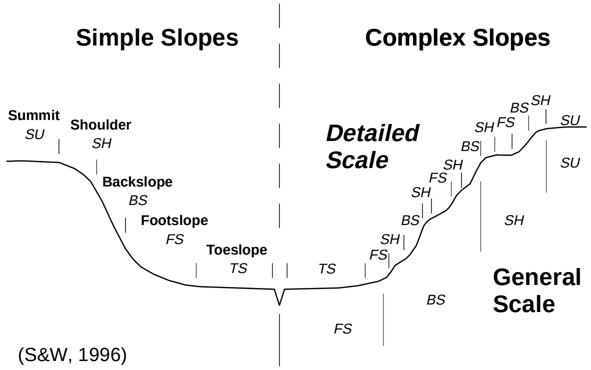
L = Linear
V = Convex
C = Concave

surface flow pathway

(S&W, 1996)

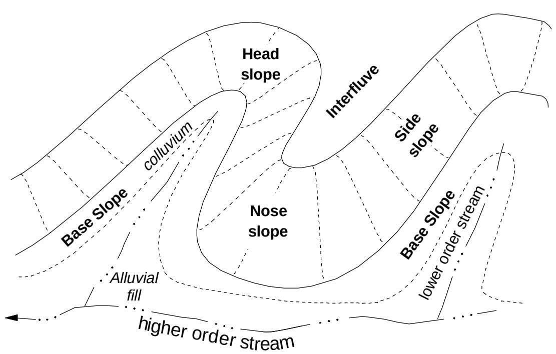
(F) **Hillslope - Profile Position** (Hillslope Position in PDP): Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

Position	Code PDP & NASIS
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS



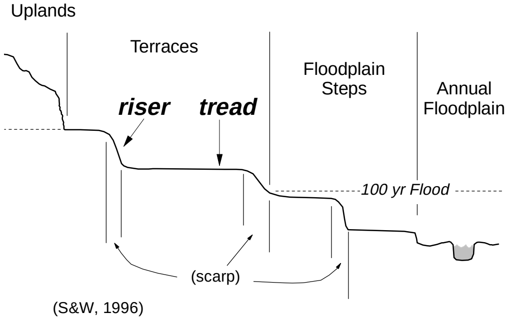
G) **Geomorphic Component** (Geomorphic Position in PDP): Three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for Hills, Terraces, Mountains, and Flat Plains; e.g., (for Hills) *nose slope* or *NS.*

1) Hills	Code	
	PDP	**NASIS**
interfluve	IF	IF
head slope	HS	HS
nose slope	NS	NS
side slope	SS	SS
base slope	---	BS

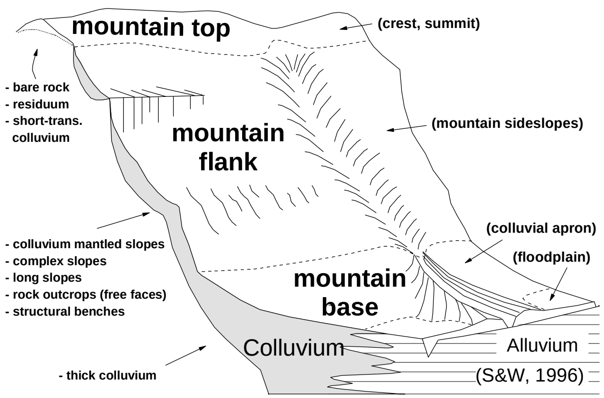


(PJS, 1996; adapted from Ruhe, 1975)

2) Terraces	Code
riser	RI
tread	TR



3) Mountains	Code
mountaintop	MT
mountainflank	MF
upper third	--
mid third	--
lower third	--
mountainbase	MB



4) Flat Plains (*proposed*)	Code

H) **Microrelief**: Small, relative differences in elevation between adjacent areas on the earth's surface; e.g., *micro-high* or *MH*; or *micro-low* or *ML*.

NOTE: Microfeature **Kind** and **Pattern** have been deleted from PDP; these phenomena and terms are now captured within the data element "Microfeature".

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SOIL TAXONOMY

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INTRODUCTION

The purpose of this section is to expand upon and augment the abbreviated soil taxonomic contents of the "Soil Profile Description Section".

HORIZON NOMENCLATURE

MASTER AND TRANSITIONAL HORIZONS -

Horizon	Criteria [1]
O	Dominated by organic matter (OM); mineral material is a small percent by volume (< 5% by weight), excludes illuvial OM; genrally darker than underlying horizons.
A	Mineral soil, formed at surface or below O, no remnant rock structure, and both or either: 1) accumulation of humified organic matter but dominated by mineral matter, and not E or B; or 2) cultivation properties. Excludes recent aeolian or alluvial deposits (< 75 cm thick) that retain stratification.
AB (or **EB**)	Dominantly A (or E) characteristics but also has some recognizable characteristics of B horizon.
A/B (or **E/B**)	Discrete, intermingled bodies of two horizons; majority of layer is A (or E).
AC	Dominantly A horizon characteristics but also has some recognizable characteristics of C horizon.
E	Mineral soil, loss of silica, iron, aluminum, or clay leaving a net concentration of sand and silt; no remnant rock structure; typically lighter color (higher value, chroma) and coarser texture than A.
E and **Bt**	Presence of thin, heavier textured lamellae within a predominantly E horizon with less clay.
BA (or **BE**)	Dominantly B characteristics but also has some recognizable attributes of A (or E) horizon.
B/A (or **B/E**)	Discrete, intermingled bodies of two horizons, majority of horizon is B (or E) material.

B	Mineral soil, formed below O, A, or E; little or no rock structure; and one or more of the following: 1) illuvial accumulation of silicate clay, Fe, Al, humus, carbonates, gypsum, or silica (one or more); 2) removal of carbonates; 3) residual accumulation of sesquioxides; 4) sesquioxide coatings; 5) alterations which form silicate clays or liberates oxides and forms pedogenic structure; 6) brittleness (includes any illuvial horizon, cemented or not; and excludes horizons of clay films coating rock fragments or covering finely stratified, unconsolidated sediments; discontinuous carbonate accumulation not contiguous to overlying horizon; and gleyed layers lacking additional pedogenic features).
BC	Dominantly B horizon characteristics but also has some recognizable characteristics of the C horizon.
B/C	Discrete, intermingled bodies of two horizons; majority of horizon is B material.
CB	Dominantly C horizon characteristics but also has some recognizable characteristics of the B horizon.
C/B	Discrete, intermingled bodies of two horizons; majority of horizon is C material.
C	Mineral soil, excludes hard bedrock; layers little affected by pedogenesis and lacks properties of O, A, E, or B horizons. May or may not be related to parent material of the solum.
W	A layer of liquid water (W) or permanently frozen ice (Wf) within the soil (excludes water / ice above soil). [2]
R	Hard bedrock.

[1] Soil Survey Staff, 1996.
[2] NRCS Soil Classification Staff, 1997; personal communication.

HORIZON SUFFIXES -

Horizon Suffixes	Criteria [1]
a	Highly decomposed organic matter (OM); rubbed fiber content < 17% (by vol.); see *e*, *i*.
b	Buried genetic horizon (not used with in organic materials or to separate organic from mineral materials.

c	Concretions or nodules; significant accumulation of cemented bodies, enriched with Fe, Al, Mn, Ti [cement not specified except excludes silica (see *q*)]; not used for calcite, dolomite, or soluable salts (see *z*).
d	Physical root restriction due to high bulk density (natural or human-made materials / conditions; e.g., lodgement till, plow pans etc.
e	Moderately (intermediately) decomposed organic matter; rubbed fiber content 17-40% (by vol.); see *a*, *i*.
f	Permafrost (permanently frozen soil or ice); excludes seasonally frozen ice; continuous subsurface ice.
ff	Dry permafrost [permanently frozen soil; not used for seasonally frozen; no continuous ice bodies (see *f*)]. [2]
g	Strong gley (Fe reduced and pedogenically removed); typically ≤ 2 chroma; may have other redoximorphic (RMF) features; not used for geogenic gray colors.
h	Illuvial organic matter (OM) accumulation (with B: accumulation of illuvial, amorphous OM sesquioxide complexes); coats sand and silt particles or more; use *Bhs* if significant accumulation of sesquioxides and moist chroma value ≤ 3.
i	Slightly decomposed organic matter; rubbed fiber content > 40% (by vol.); see *a*, *e*.
j	Jarosite accumulation [2]; e.g., acid sulfate soils.
jj	Evidence of cryoturbation [2]; e.g., irregular or broken boundaries, sorted rock fragments (patterned ground), or O.M. in lower boundary between active layer and permafrost layer.
k	Pedogenic accumulation of carbonates; e.g. $CaCO_3$.
m	Strong pedogenic cementation or induration (> 90% cemented, even if fractured); physically root restrictive; you can indicate cement type by using letter combinations; e.g., *km* - carbonates, *qm*- silica, *kqm* - carbonates and silica; *sm* - iron, *ym* - gypsum; *zm* - salts more soluable than gypsum.
n	Pedogenic, exchangeable sodium accumulation.
o	Residual accumulation of sesquioxides.
p	Tillage or other disturbance of surface layer (pasture, plow, etc.). Designate *Op* for disturbed organic surface; *Ap* for mineral surface even if the layer clearly was originally an E, B, C, etc.
q	Accumulation of secondary (pedogenic) silica.

r	Used with C to indicate weathered or soft bedrock (root restrictive saprolite or soft bedrock; partially consolidated sandstaone , siltstone or shale; Excavation Difficulty classes are *low* to *high*).
s	Illuvial accumulation of amorphous, dispersible, sesquioxides and organic matter complexes and color value or chroma ≥ 4. Used with B horizon; used with h as *Bhs* if color value or chroma is ≤ 3.
ss	Slickensides; e.g., oblique shear faces 20 - 60º off horizontal; due to shrink-swell clay action; wedge-shaped peds and seasonal surface cracks are also commonly present.
t	Illuvial accumulation of silicate clays (clayskins, lamellae, or clay bridging in some part of the horizon).
v	Plinthite (high Fe, low OM, reddish contents; firm to very firm moist consistence; irreversible hardening with repeated wetting and drying).
w	Incipient color or pedogenic structure development; minimal illuvial accumulations (excluded from use with transition horizons).
x	Fragipan characteristics (brittleness, firmness, bleached prisms).
y	Pedogenic accumulation of gypsum.
z	Pedogenic accumulation of salts more soluable than gypsum; e.g., NaCl, etc.

[1] Soil Survey Staff, 1996
[2] NRCS Soil Classification Staff, 1998; personal communication.

HORIZON NOMENCLATURE CONVERSION CHARTS -

Master Horizons and Combinations			
1951 [1]	**1962** [2]	**1981** [3]	**1997** [4]
---	**O**	**O**	**O**
Aoo	---	(see ***Oi***)	(see ***Oi***)
Ao	**O1**	**Oi** and/or **Oe**	**Oi** and/or **Oe**
---	**O2**	**Oe** and/or **Oa**	**Oe** and/or **Oa**
A	**A**	**A**	**A**
A1	**A1**	**A**	**A**
A2	**A2**	**E**	**E**
A3	**A3**	**AB** or **EB**	**AB** or **EB**
AB	**AB**	-----	-----
A&B	**A&B**	**A/B** or **E/B**	**A/B** or **E/B**
AC	**AC**	**AC**	**AC**

B	**B**	**B**	**B**
B1	**B1**	**BA** or **BE**	**BA** or **BE**
B&A	**B&A**	**B/A** or **B/E**	**B/A** or **B/E**
B2	**B2**	**B** or **Bw**	**B** or **Bw**
B3	**B3**	**BC** or **CB**	**BC** or **CB**
G	---	---	---
Cca	---	---	---
Ccs	---	---	---
---	**C**	**C**	**C**
D	---	---	---
Dr	**R**	**R**	**R**
---	---	---	**W**

[1] Soil Survey Staff, 1951.
[2] Soil Survey Staff, 1962.
[3] Guthrie and Witty, 1982. Additional changes to lithologic discontinuities.
[4] NRCS Soil Classification Staff, 1997; personal communication.

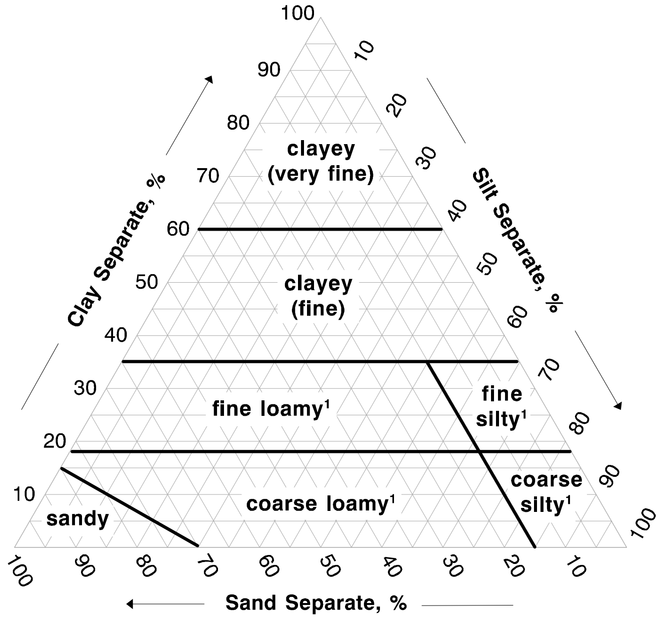
Horizon Suffixes
(also called "Horizon Subscripts", and "Subordinate Distinctions")

1951 [1]	1962 [2]	1981 [3]	1997 [4]
---	---	**a**	**a**
b	**b**	**b**	**b**
ca	**ca**	(see ***k***)	(see ***k***)
cn	**cn**	**c**	**c**
cs	**cs**	(see ***y***)	(see ***y***)
---	---	**e**	**e**
f	**f**	**f**	**f**
---	---	---	**ff**
g	**g**	**g**	**g**
h	**h**	**h**	**h**
ir	**ir**	(see ***s***)	(see ***s***)
---	---	**i**	**i**
---	---	---	**j**
---	---	---	**jj**
(see ***ca***)	(see ***ca***)	**k**	**k**
m	**m**	**m**	**m**
sa	**sa**	**n**	**n**
---	---	**o**	**o**
p	**p**	**p**	**p**

(see ***si***)	(see ***si***)	**q**	**q**
---	**r**	**r**	**r**
(see ***ir***)	(see ***ir***)	**s**	**s**
si	**si**	(see ***q***)	(see ***q***)
---	---	---	**ss** (1991)
t	**t**	**t**	**t**
---	---	**v**	**v**
---	---	**w**	**w**
x	**x**	**x**	**x**
(see ***cs***)	(see ***cs***)	**y**	**y**
	sa	**z**	**z**

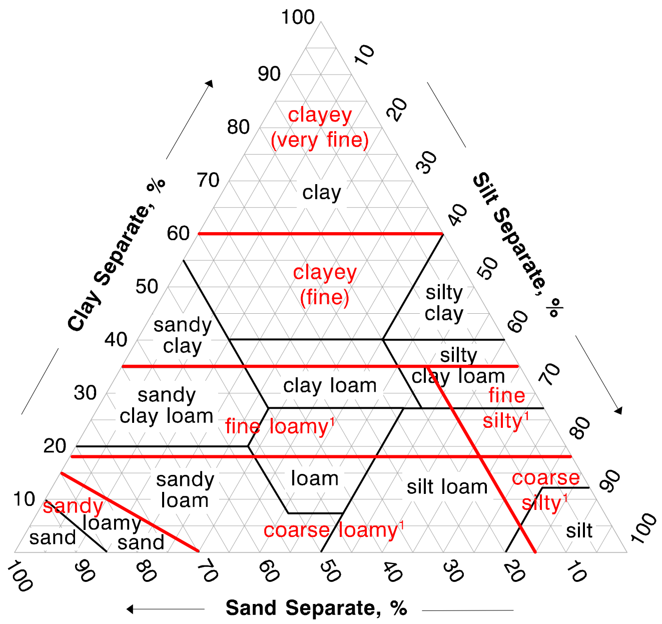
[1] Soil Survey Staff, 1951.
[2] Soil Survey Staff, 1962
[3] Guthrie and Witty, 1982.
[4] NRCS Soil Classification Staff, 1997; personal communication.

Texture Triangle:
Soil Textural Family Classes (——)



[1] Very fine sand (0.05 - 0.1) is treated as silt for family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between the silty and loamy classes.

Combined Texture Triangles:
Fine Earth Texture Classes (——) &
Soil Textural Family Classes (——)



[1] Very fine sand (0.05 - 0.1) is treated as silt for family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between the silty and loamy classes.

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GEOLOGY

Compiled by: P.J. Schoeneberger, D.A. Wysocki, and E.C. Benham, NRCS, Lincoln, NE.

INTRODUCTION

The purpose of this section is to expand and augment the geologic information found or needed in the "Site Description Section" and "Soil Profile Description Section".

BEDROCK - KIND

e.g., *limestone*. (The following table is repeated here from the "Site Selection Section" for convenience in using the rock charts).

Kind	Code [1] PDP	Code [1] NASIS	Kind	Code [1] PDP	Code [1] NASIS
IGNEOUS-INTRUSIVE					
diabase	--	DIA	monzonite	--	MON
diorite	--	DIO	peridotite	--	PER
gabbro	--	GAB	pyroxenite	--	PYX
granite	I4	GRA	syenite	--	SYE
granodiorite	--	GRD	syenodiorite	--	SYD
IGNEOUS-EXTRUSIVE					
aa (lava)	P8	AAL	pahoehoe (lava)	P9	PAH
andesite	I7	AND	pumice (flow, coherent)	E6	PUM
basalt	I6	BAS	rhyolite	--	RHY
dacite	--	DAC	scoria (coherent, mass)	E7	SCO
latite	--	LAT	trachyte	--	TRA
obsidian	--	OBS			
IGNEOUS-PYROCLASTIC					
ignimbrite	--	IGN	tuff breccia	P7	TBR
pyroclastics (coherent)	P0	PYR	volcanic breccia	P4	VBR
tuff	P1	TUF	volcanic breccia, acidic	P5	AVB
tuff, acidic	P2	ATU	volcanic breccia, basic	P6	BVB
tuff, basic	P3	BTU			

METAMORPHIC					
amphibolite	--	AMP	metavolcanics	--	MVO
gneiss	M1	GNE	migmatite	--	MIG
granofels	--	GRF	mylonite	--	MYL
granulite	--	GRL	phyllite	--	PHY
greenstone	--	GRE	schist	M5	SCH
hornfels	--	HOR	serpentinite	M4	SER
marble	L2	MAR	slate	M8	SLA
metaconglomerate	--	MCN	soapstone (talc)	--	SPS
metaquartzite	M9	MQT			
SEDIMENTARY-CLASTICS					
arenite	--	ARE	porcellanite	--	POR
argillite	--	ARG	sandstone	A0	SST
arkose	A2	ARK	sandstone, calcareous	A4	CSS
breccia, non-volcanic (angular fragments)	--	NBR	shale	H0	SHA
claystone	--	CST	shale, acid	--	ASH
conglomerate (rounded fragments)	C0	CON	shale, calcareous	H2	CSH
conglomerate, calcar.	C2	CCN	shale, clayey	H3	YSH
graywacke	--	GRY	siltstone	T0	SIS
mudstone	--	MUD	siltstone, calcareous	T2	CSI
orthoquartzite	--	OQT			
EVAPORITES, ORGANICS, AND PRECIPITATES					
chalk	L1	CHA	limestone, arenaceous	L5	ALS
chert	--	CHE	limestone, argillaceous	L6	RLS
coal	--	COA	limestone, cherty	L7	CLS
dolostone	L3	DOL	limestone, phosphatic	L4	PLS
gypsum	--	GYP	travertine	--	TRA
limestone	L0	LST	tufa	--	TUA
INTERBEDDED					
limestone-sandst.-shale	B1	LSS	sandstone-shale	B5	SSH
limestone-sandstone	B2	LSA	sandstone-siltstone	B6	SSI
limestone-shale	B3	LSH	shale-siltstone	B7	SHS
limestone-siltstone	B4	LSI			

[1] Definitions for bedrock are found in the "Glossary of Landforms and Geologic Terms", NSSH - Part 629 (Soil Survey Staff, 1996c), and in the "Glossary of Geology" (Bates, et al., 1987).

ROCK CHARTS

The following rock charts (**Igneous**, **Metamorphic**, and **Sedimentary & Volcaniclastic**) summarize grain size, composition, or genetic differences between related rock types. ***NOTE***: 1) Most, but not all, of the rocks in these tables are found in the NASIS (and PDP) choice lists (uncommon in the pedosphere). These additional rock types are included in these charts for completeness and to aid in the use of geologic literature. 2) Most, but not all of the rocks presented in these tables can be definitively identified in the field; some may require additional laboratory analyses; e.g., grain counts, thin section analyses, etc.

IGNEOUS ROCKS CHART

CRYSTALLINE TEXTURE	KEY MINERAL COMPOSITION							
	Acidic (≈ Felsic) Potasium (K) Feldspar > 2/3 of Total Feldspar Content		*Intermediate* (- - -) Potasium (K) Feldspar & Plagioclase (Na, Ca) Feldspar in about equal proportions		*Basic* (≈ mafic) Plagioclase (Na, Ca) Feldspar > 2/3 of Total Feldspar Content			*Ultrabasic* (≈ ultramafic) Pyroxene and Olivine
					Sodic (Na) Plagioclase		Calcic (Ca) Plagioclase	
	Quartz	***No Quartz***	***Quartz***	***No Quartz***	***Quartz***	***No Quartz***		
PEGMATITIC (very coarse, uneven-sized crystal grains)	granite pegmatite	syenite pegmatite	← monzonite-pegmatite →			diorite pegmatite	gabbro pegmatite	peridotite (mostly olivine)
PHANERITIC (crystals visible and of nearly equal size)	granite	syenite	quartz monzonite	monzonite	quartz-diorite granodiorite	diorite	gabbro	pyroxenite (mostly pyroxene)
PORPHYRITIC (relatively few visible crystals within a fine-grained matrix)	granite porphyry	syenite porphyry	quartz-monzonite porphyry	monzonite porphyry	quartz-diorite porphyry	diorite porphyry	diabase	
	rhyolite porphyry	trachyte porphyry	quartz-latite porphyry	latite porphyry	dacite porphyry	andesite porphyry	porphyry basalt	
APHANITIC (crystals visible only with magnification) micro.[1] crypto.[2]	rhyolite	trachyte	quartz latite	latite	dacite	andesite	basalt	} lava[3]
GLASSY (amorphous: no crystalline structure)	obsidian (and its varieties: perlite, pitchstone, pumice, scoria) pyroclastics are shown on the Sedimentary and Volcaniclastic Rocks chart.							

[1] Microcrystalline - crystals visible with ordinary magnification (hand lens, simple microscope).
[2] Cryptocrystalline - crystals only visible with SEM
[3] Lava - generic name for extrusive flows of non-clastic, aphanitic rocks (rhyolite, andesite, basalt)

METAMORPHIC ROCKS CHART

NONFOLIATED STRUCTURE			*CRUDE ALIGNMENT*	*FOLIATED STRUCTURE (e.g. banded, etc.)*				
CONTACT METAMORPHISM			MECHANICAL METAMORPHISM	REGIONAL METAMORPHISM				PLUTONIC METAMROPHISM
Low Grade	*Medium Grade*	*High Grade*	*Very Low Grade*		*Low Grade*	*Medium Grade*	*High Grade*	*Extreme Grade*
	granofels hornfels marble metaquartzite serpentinite soapstone *(talc)*		crush breccia mylonite ← metaconglomerate → ← metavolcanics →	slate	phyllite greenstone	schist amphibolite	gneiss granulite	migmatite

* Not all rock types listed here can be definitively identified in the field (e.g. may require grain counts)
** Not all rock types shown here are available on Bedrock-Kind choice list. They are included here for completeness and as aids to using geologic literature.

SEDIMENTARY AND VOLCANICLASTIC ROCKS

CLASTIC

Dominant Grain Size

Very Fine *(Argillaceous)* <0.002 mm	Fine *(Argillaceous)* 0.002-0.05 mm	Medium *(Arenaceous)* 0.05 - 2.0 mm	Coarse *(Rudaceous)* > 2.0 mm
		Sandstones (ss):	**breccia** *(non-volcanic, angular frags)*
	argillite	**arenite**	
	shale	**arkose** *(mainly feldspar)*	
		glauconitic ss ("greensand")	**conglomerate** *(non-volcanic, rounded frags)*
← **mudstone** →	← **mudstone** →	**graywacke** *(dark, "dirty" ss)*	
claystone	**siltstone**	**orthoquartzite** *(mainly quartz)*	

VOLCANICLASTICS *(includes Pyroclastics)*

Very Fine	Fine	Medium	Coarse
← ignimbrite	ignimbrite	ignimbrite →	**agglomerate** *(rounded frags)*
← tuff	tuff	tuff →	**volcanic breccia** *(angular frags)*
← pumice	pumice	pumice	pumice →
(specific gravity <1.0; highly vesicular)			
← scoria	scoria	scoria	scoria →
(specific gravity >2.0; slightly to moderately vesicular)			

NONCLASTIC

Chemical: Evaporates	Chemical: Precipitates	Biochemical: Accretionates	Organic: Reduzates
anhydrite *($CaSO_4$)*	CARBONATE ROCKS Limestones (ls) *(>50% calcite)*		
	chemical types	accretionary types	
gypsum *($CaSO_4 \bullet 2H_2O$)*	caliche	biostromal ls	**black shale** *(organics and fine sediments)*
	travertine	organic reef	
	tufa	pelagic ls	
		(chalk)	
halite *(NACl)*		bio-clastic types	bituminous ls
		coquina	bog iron ores
		oolitic ls	
		lithographic ls	**coal**
	(altered types):		
	dolostone *(>50% calcite + dolomite)*		
	phosphatic limestone		

OTHER NONCLASTIC ROCKS

siliceous rocks (SiO_2 dominated):
- chert (jasper, chalcedony, opal)
- diatomite

rock phosphate

iron bearing rocks ($Fe\text{-}SiO_2$ dominated)

NORTH AMERICAN GEOLOGIC TIME SCALE [1]

Geologic Period	Geologic Epoch	Sub-Division	O Isotope Stage [2]	Years (BP)
QUATERNARY	**Holocene**		(1)	0 to 10-12 ka*
	Pleistocene — *Late Pleistocene*	Late Wisconsin	(2)	10-12 to 28 ka
		Middle Wisconsin	(3, 4)	28 to 71 ka
		Early Wisconsin *Late Sangamon*	(5a - 5d)	71 to 115 ka
		Sangamon	(5e)	115 to128 ka
	Middle Pleistocene	Late - Mid Pleistocene *(Illinoian)*	(6 - 8)	128 to 300 ka
		Middle - Mid Pleistocene	(9 - 15)	300 to 620 ka
		Early - Mid Pleistocene	(16 - 19)	620 to 770 ka
	Early Pleistocene			770 ka to 1.64 Ma**
TERTIARY	**Pliocene**			1.64 to 5.2 Ma
	Miocene			5.2 to 23.3 Ma
	Oligocene			23.3 to 35.4 Ma
	Eocene			35.4 to 56.5 Ma
	Paleocene			56.5 to 65.0 Ma
CRETACEOUS	*Late Cretaceous*			65.0 to 97.0 Ma
	Early Cretaceous			97.0 to 145.6 Ma
JURASSIC				145.6 to 208.8 Ma
TRIASSIC				208.8 to ≈ 243.0 Ma
PERMIAN				≈ 243.0 to 290.0 Ma
PENNSYLVANIAN				290.0 Ma to 322.8 Ma
MISSISSIPPIAN				322.8 to 362.5 Ma
DEVONIAN				362.5 to 408.5 Ma
SILURIAN				408.5 to 439.0 Ma
ORDIVICIAN				439.0 to 510.0 Ma

CAMBRIAN	510.0 to ≈ 570.0 Ma
PRE-CAMBRIAN	> ≈ 570.0 Ma

* ka = x 1,000
** Ma = x 1,000,000 (≈ = approximately)
[1] Modified from Morrison, 1991; Sibrava, et al., 1986; and Harland, et al., 1990.
[2] Oxygen isotope.

TILL TERMS

Genetic classification and relationships of till terms commonly used in soil survey. (P.J. Schoeneberger, 1994; adapted from Goldthwaite and Matsch, 1988.)

Location (Facies of tills grouped by position at deposition)	**Till Types** **Terrestrial**	 **Waterlaid**
Proglacial Till (at the front of, or in front of)	proglacial flow till	waterlaid flow till
Supraglacial Till (on top of, or within upper part of)	supraglacial flow till [1, 3] supraglacial melt-out till [1] (ablation till - NP) [1] (lowered till - NP) [2] (sublimation till - NP) [2]	--------------
Subglacial Till (within the lower part of, or beneath)	lodgement till [1] subglacial melt-out till subglacial flow till (= “squeeze till” [2, 3]) (basal till - NP) [1] (deformation till - NP) [2] (gravity flow till - NP) [2]	waterlaid melt-out till waterlaid flow till iceberg till (= “ice-rafted”)

[1] *Ablation till* and *basal till* are very generic terms that describe “relative position” of deposition which have been widely replaced by multiple, specific terms that convey both relative position and process. *Ablation till*, formerly used to describe any comparatively permeable debris deposited within or above stagnant ice is replaced by *supraglacial melt-out till*, *supraglacial flow till*, etc. *Basal till*, formerly used for any dense, non-

sorted till presumed to be subglacial material, is replaced by *lodgement till*, *subglacial melt-out till*, *subglacial flow till*, etc.

[2] Additional (proposed) till terms that have not gained wide acceptance, and are therefore considered to be *Not Preferred*, and should not be used (shown for completeness).

[3] Also called *gravity flow till* (not preferred).

VOLCANICLASTIC TERMS

Volcaniclastic Deposits (Unconsolidated)			
Size Scale: 0.062 mm [1]	2 mm	64 mm [1]	
<——— **tephra** ———> (all ejecta)			
<——— **ash** ———>		<— **cinders** —> (specific gravity > 1.0 & < 2.0)	<— **bombs** —> (fluid-shaped coarse fragments)
<———> **fine ash**	<———> **coarse ash**	<— **lapilli** —> (specific gravity > 2.0)	<— **blocks** —> (angular-shaped coarse fragments)
		<——— **scoria** [2] ———> (slightly to moderately vesicular; specific gravity > 2.0)	
	<———> **pumiceous ash** [3]	<——— **pumice** ———> (highly vesicular; specific gravity < 1.0)	
Associated Lithified (Consolidated) Rock Types			
<———> **fine tuff**	<———> **coarse tuff**	<–**lapillistone**–> (sp. gr. > 2.0)	
<—— **ignimbrite** ——> (consolidated ash flows and nuee ardentes)		<——— **agglomerate** ———> (rounded, volcanic coarse fragments)	
		<——— **volcanic breccia** ———> (angular, volcanic coarse fragments)	

[1] These size breaks are taken from geologic literature (Fisher, 1989) and based on the modified Wentworth scale. The 0.062 mm break is very close to the USDA's 0.05 mm break between *coarse silt* and *very fine sand* (Soil Survey Staff, 1993). The 64 mm break is close to the USDA's 76 mm break between *coarse gravel* and *cobbles*. (See "Relationships Among Particle Size Classes and Different Systems" in the "Profile / Pedon Description Section", under "Soil Texture".)

[2] A lower size limit of 2 mm is required in Soil Taxonomy, but is not required in geologic usage (Fisher, 1989).
[3] The descriptor for pumice smaller than 2 mm, as used in soil science. Geologic usage does not include any size restrictions; solely based upon composition.

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LOCATION

Compiled by: P.J. Schoeneberger, W. Lynn, D.A. Wysocki, and E.C. Benham, NRCS, Lincoln, NE.

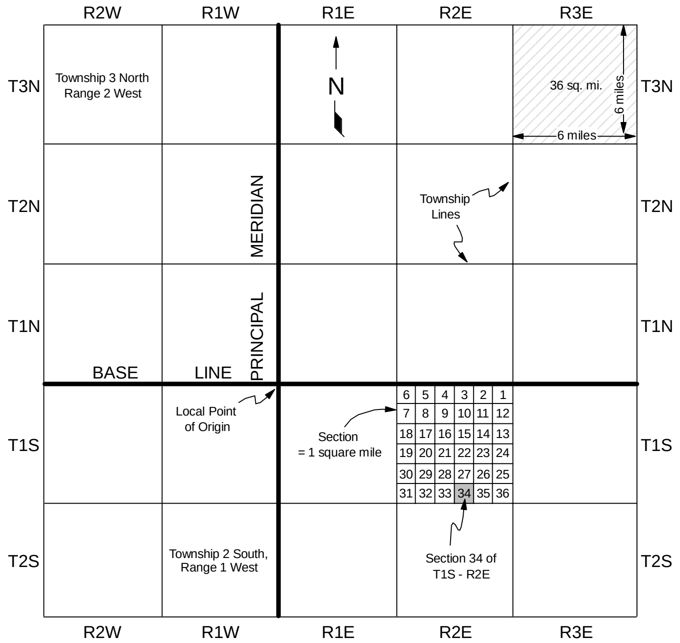
PUBLIC LAND SURVEY

The Public Land Survey is the most widely used scheme in the U.S. for land surveying (legal location). Historically, many soil descriptions have been located using this system. Some states are not part of the Public Land Survey System and use the State Plane Coordinate System. The states include Connecticut, Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio (parts), Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia.

The Public Land Survey System consists of a standard grid composed of regularly spaced squares which are uniquely numbered in reference to north-south Principle Meridians and to various, local, east-west Baselines. These squares are shown on U.S. Geological Survey topographic maps.

TOWNSHIPS AND RANGES - The primary grid network consists of squares (6 miles on a side) called Townships. Each Township can be uniquely identified using two coordinates: 1) **Township** (the north-south coordinate relative to a local, east-west Baseline); and 2) **Range** (the east-west coordinate relative to a local north-south Principle Meridian). (The local Baselines and Principle Meridians for the coterminous U.S. are shown on pp. 82-83, Thompson, 1987.) Commonly in soil survey, the local Baseline and the Principle Meridian are not recorded. The name of the appropriate USGS topographic 7.5-minute or 15-minute quadrangle is recorded instead; e.g., *Pleasant Dale, NE, 7.5 min. Quad*.

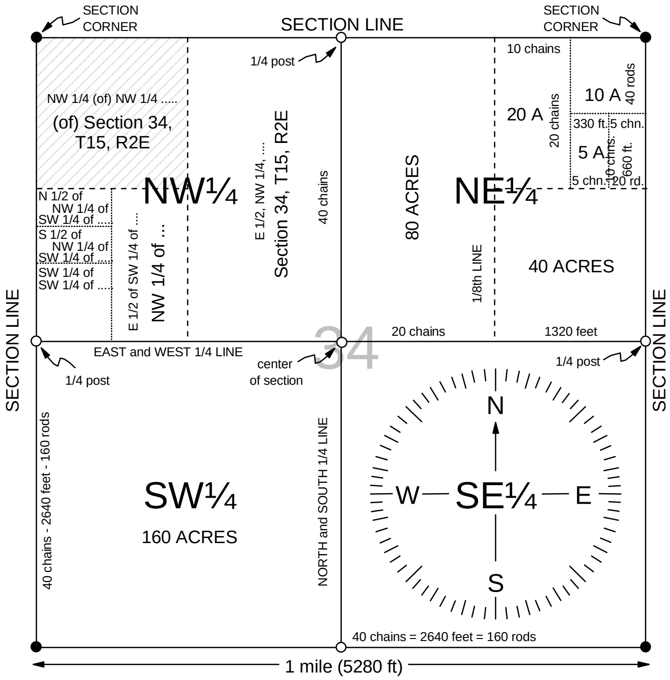
The **Township numbers** run in rows that parallel the local Baseline. Each Township row is sequentially numbered relative to the row's distance from, and whether it's north (N) or south (S) of the local Baseline; e.g., *T2N* (for the second township row north of the local Baseline). The **Range numbers** run in rows that parallel the local Principle Meridian. Range rows are sequentially numbered relative to the row's distance from, and whether it's east (E) or west (W) of the Principle Meridian e.g., *R2E* (for the second Range row east of the Principle Meridian in the area). The combined coordinates identify a unique square in the area; e.g., *T1S, R2E* (for Township 1 South and Range 2 East).



Modified from Mozola, 1989.

SECTIONS - Each Township square is further subdivided into smaller squares called **Sections**, which make up the secondary grid in this location system. Sections are 1 mile on a side (for a total of 36 Sections within each Township). The Section numbers begin in the northeast corner of a Township and progress sequentially in east-west rows, wrapping back and forth to fill in the Township; e.g., *Section 34, T1S, R2E* (for Section 34 of Township 1 South, Range 2 East).

CAUTION: Due to the curvature of the earth (trying to fit a flat grid to a non-flat surface), inaccessible areas (e.g., large swamps), or to joins to other survey schemes (e.g., pre-existing Metes and Bounds), you will occasionally find irregularities in the grid system. Adjustments to the grid layout result in non-standard sized, partial sections and/or breaks in the usual numbering sequence of sections. In some areas, **Lots** are appended to the northern-most tier of Sections in a Township to enable the adjoining Township to begin along the Baseline.



Modified from Mozola, 1989.

SUB-DIVISIONS - The tertiary (lower) levels of this system consist of subdividing Sections into smaller pieces that are halves or quarters of the Section. The fraction (1/2, 1/4) that the area of land represents of the Section is combined with the compass quadrant that the area occupies within the Section; e.g., *SW 1/4, Section 34, T1S, R2E* (for the southwest quarter of Section 34, Township 1 South, Range 2 East). Additional subdivisions, by quarters or halves, can be continued to describe progressively smaller areas. The information is presented consecutively, beginning with the smallest subdivision; e.g., *N 1/2, NW 1/4, SW 1/4, NW 1/4, of Section 34, T1S, R2E* (for the north half of the northwest quarter of the northeast quarter of the southern half of Section 8, Township 1 South, Range 2 East).

NOTE: **Point locations** (e.g., soil pits) are measured, traditionally in English units, with reference to a specified section corner or quarter corner (1/4 post); e.g., *660 feet east and 1320 feet north of southwest corner post, Section 34, T1S, R2E*.

STATE PLANE COORDINATE SYSTEM

The State Plane Coordinate System is the second most widely used scheme in the U.S. for land surveying (legal location). Historically, many soil descriptions have been located using this system. The states that use this system are: Connecticut, Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio (parts), Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia. The other states use the Public Land Survey System.

The State Plane Coordinate System is based upon two principle lines in the state; a north-south line and an east-west line. Most USGS topographic quadrangle maps indicate the state grids by tick marks along the neatlines (outer-most border) on 7.5-minute topographic maps of states that use State Plane Coordinates.

Specific coordinates for a point are described by distance (commonly in meters) and primary compass direction [north (northing) / south (southing) and east (easting) / west (westing)] relative to the principle lines; e.g., *10,240 m easting, and 1,234 m northing*.

Contact the local State NRCS Office or the Regional MO Office for state-specific details.

UNIVERSAL TRANSVERSE MERCATOR (UTM) RECTANGULAR COORDINATE SYSTEM

The Universal Transverse Mercator (UTM) Rectangular Coordinate System is widely available and has been advocated as the universal map coordinate standard by the USGS (Morrison, 1987). It is a metric-based system whose primary unit of measure is the meter. The dominant UTM projection circles the globe and spans a wide range of latitudes [80° S through 84° N (the extreme polar areas require a different projection)]. The dominant projection is divided into 60 zones around the world. Zones begin at the International Date Line Meridian in the Pacific and progress eastward around the world. Each zone extends from pole to pole and spans 6 degrees of longitude. The logic of the UTM grid is similar to that of State Plane Coordinates. The UTM System uses 2 values to arrive at unique coordinates for any point on the earth's surface: 1) distance (and direction) away from the Equator called **Northing** (or **Southing**) to identify the hemisphere, and 2) distance away from the local zone's Meridian called an **Easting**.

Around the perimeter of 7.5-minute USGS topographic quadrangle maps are blue tic marks which intersect the map boundary at 1 km intervals. The

Northing measures the distance from the Equator northward (in the Southern Hemisphere the Southing measures the distance from the Equator southward); e.g., *4, 771,651 meters N*. The Easting measures the distance eastward from the local Meridian (the same Easting designation is used in the Southern Hemisphere); e.g., *305, 904 meters E*. A complete example: *305, 904 meters E; 4, 771,651 meters N; 16, N* (for the location of the capitol dome in Madison, Wisconsin, which is located within zone 16).

If the USGS topographic map has a complete kilometer grid (shown in blue), measure the distance (cm) from the point of interest to the closest north-south reference line (to the west of the point of interest). If the map scale is 1:24000, multiply the measured distance (cm) by 240 to calculate the actual ground distance in meters. If the scale is 1:20000, multiply by 200, etc. Add this partial distance to that of the chosen km reference line to obtain the Easting to be recorded.

If no kilometer grid is shown on the topographic map, locate the kilometer tic points along the east-west perimeters immediately south of the point of interest. Place a straight edge between the tic marks and draw a line segment south of the point of interest. Measure the distance (cm) from the point of interest to the east-west line segment. Multiply this distance by the appropriate map scale factor as mentioned above. Add this distance to that of the east-west baseline to obtain the Northing (distance from the Equator). The Northing must be identified as *N* for sites north of the Equator and *S* for sites south of the Equator.

Alternatively, a variety of clear UTM templates are commercially available which can be overlain upon the topographic map to facilitate determining distances and coordinates.

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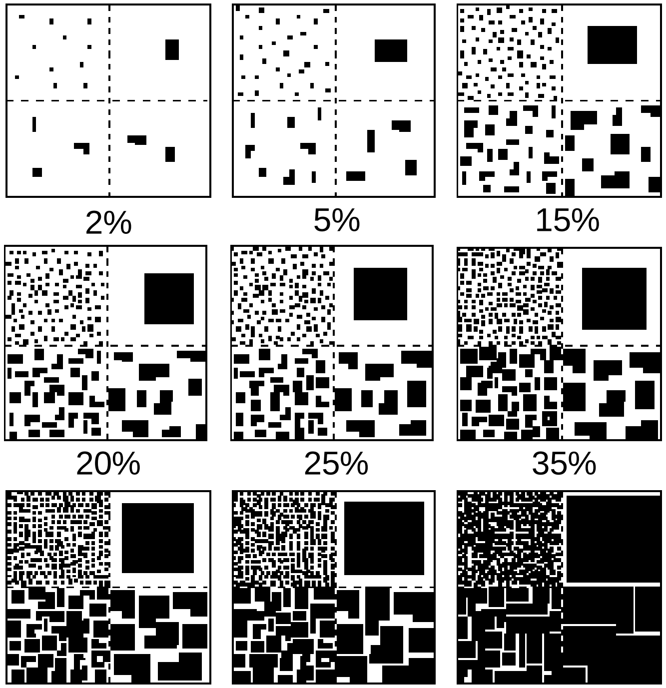
MISCELLANEOUS

Compiled by: P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, and H. LaGarry, NRCS, Lincoln, NE.

EXAMPLES OF PERCENT OF AREA COVERED

The following graphic can be used for various data elements to convey "Amount" or "Quantity". ***NOTE***: Within any given box, each quadrant contains the same total area covered, just different sized objects.



2% 5% 15%

20% 25% 35%

50% 60% 90%

METRIC TO ENGLISH

Known	Symbol	Multiplier	Product	Symbol
LENGTH				
micron (=10,000 Angstrom units)	µ	3.9370 x 10^{-5}	inches	*in* or "
millimeters	*mm*	0.03937	inches	*in* or "
centimeters	*cm*	0.0328	feet	*ft* or '
centimeters	*cm*	0.03937	inches	*in* or "
meters	*m*	3.2808	feet	*ft* or '
meters	*m*	1.0936	yards	*yd*
kilometers	*km*	0.6214	miles(statute)	*mi*
AREA				
square centimeters	*cm²*	0.1550	square inches	*in²*
square meters	*m²*	10.7639	square feet	*ft²*
square meters	*m²*	1.1960	square yards	*yd²*
square kilometers	*km²*	0.3861	square miles	*mi²*
hectares	*ha*	2.471	acres	*ac*
VOLUME				
cubic centimeters	*cm³*	0.06102	cubic inches	*in³*
cubic meters	*m³*	35.3146	cubic feet	*ft³*
cubic meters	*m³*	1.3079	cubic yards	*yd³*
cubic meters	*m³*	0.0008107	acre-feet (= 43,560 ft)	*acre-ft*
cubic kilometers	*km³*	0.2399	cubic miles	*mi³*
liters (=1000 cm³)	*l*	1.0567	quarts (U.S.)	*qt*
liters	*l*	0.2642	gallons (U.S.)	*gal*
milliliter	*ml*	0.0338	ounces	*oz*
1 milliliter = 1 cm³ = 1 gm (H_20, at 25°C)				
MASS				
grams	*g*	0.03527	ounces (avdp.)	*oz*
kilograms	*kg*	2.2046	pounds (avdp.)	*lb*
megagrams (= metric tons)	*Mg*	1.1023	short tons (2000 lb)	
megagrams	*Mg*	0.9842	long tons (2240 lb)	

ENGLISH TO METRIC

Known	Symbol	Multiplier	Product	Symbol
LENGTH				
inches	*in* or "	2.54×10^4	micron [= 10,000 Angstrom units (A)]	μ
inches	*in* or "	2.54	centimeters	*cm*
feet	*ft* or '	30.48	centimeters	*cm*
feet	*ft* or '	0.3048	meters	*m*
yards	*yd*	0.9144	meters	*m*
miles (statute)	*mi*	1.6093	kilometers	*km*
AREA				
square inches	in^2	6.4516	sq. centimeters	cm^2
square feet	ft^2	0.0929	sq. meters	m^2
square yards	yd^2	0.8361	sq. meters	m^2
square miles	mi^2	2.5900	sq. kilometers	km^2
acres	*ac*	0.405	hectares	*ha*
VOLUME				
acre-feet	*acre-ft*	1233.5019	cubic meters	m^3
acre-furrow-slice ≈ 2,000,000 lbs	*afs* (assumes b.d. = 1.3g/cm^3)	= 6 in. thick layer that's 1 acre square		
cubic inches	in^3	16.3871	cubic centimeters	cm^3
cubic feet	ft^3	0.02832	cubic meters	m^3
cubic yards	yd^3	0.7646	cubic meters	m^3
cubic miles	mi^3	4.1684	cubic kilometers	km^3
gallons (U.S. liquid) (= 0.8327 Imperial gal)	*gal*	3.7854	liters	*l*
quarts (U.S. liquid)	*qt*	0.9463	liters (= 1000 cm^3)	*l*
ounces	*oz*	29.57	milliliters	*ml*
1 milliliter = 1 cm^3 = 1 gm (H_20, at 25°C)				
MASS				
ounces (avdp.)	*oz*	28.3495	grams	*g*
ounces (avdp.) (1 troy oz. = 0.083 lb)				
pounds (avdp.)	*lb*	0.4536	kilograms	*kg*
short tons (2000 lb)		0.9072	megagrams (= metric tons)	*Mg*
long tons (2240 lb)		1.0160	megagrams	*Mg*

COMMON CONVERSION FACTORS

Known	Symbol	Multiplier	Product	Symbol
acres	*ac*	0.405	hectares	*ha*
acre-feet	*acre-ft*	1233.5019	cubic meters	m^3
acre-furrow-slice	*afs*	= 6 in. thick layer that's 1 acre square		
≈ 2,000,000 lbs	(assumes b.d. = 1.3g/cm³)			
Angstrom units	*A*	1×10^{-8}	centimeters	*cm*
Angstrom units	*A*	1×10^{-4}	microns	*µm*
Angstrom units	*A*	1.0133×10^{6}	dynes/cm^2	
Atmospheres	*atm*	760	mm of mercury (Hg)	
BTU (mean)	*BTU*	777.98	foot-pounds	
centimeters	*cm*	0.0328	feet	*ft* or '
centimeters	*cm*	0.03937	inches	*in* or "
centimeters/second	*cm/s*	1.9685	feet/minute	*ft/min.*
centimeters/second	*cm/s*	1.9685	feet/minute	*ft/min.*
cm of mercury at 0° C		0.0224	miles/hour	*mph*
chain (US)		66	feet	*ft*
chain (US)		4	rods	
centimeters	cm^3	0.06102	cubic inches	in^3
cubic centimeters	cm^3	2.6417×10^{-4}	gallons (U.S.)	*gal*
cubic centimeters	cm^3	0.999972	milliliters	*ml*
cubic centimeters	cm^3	0.0338	ounces (US)	*oz*
cubic feet	ft^3	0.02832	cubic meters	m^3
cubic feet (H₂0, 60°F)	ft^3	62.37	pounds	*lbs*
cubic feet	ft^3	0.03704	cubic yards	yrd^3
cubic inches	in^3	16.3871	cubic centimeters	cm^3
cubic kilometers	km^3	0.2399	cubic miles	mi^3
cubic meters	m^3	35.3146	cubic feet	ft^3
cubic meters	m^3	1.3079	cubic yards	yd^3
cubic meters	m^3	0.0008107	acre-feet (= 43,560 ft)	*acre-ft*
cubic miles	mi^3	4.1684	cubic kilometers	km^3
cubic yards	yd^3	0.7646	cubic meters	m^3
degrees (angle)	°	0.0028	circumfrences	
Faradays		96500	coulombs (abs)	
fathoms		6	feet	*ft*
feet	*ft* or '	30.4801	centimeters	*cm*
feet	*ft* or '	0.3048	meters	*m*
feet	*ft* or '	0.0152	chains (US)	
feet	*ft* or '	0.0606	rods (US)	
foot pounds		0.0012854	BTU (mean)	*BTU*
gallons (US)	*gal*	3.7854	liters	*l*
gallons (US)	*gal*	0.8327	Imperial gallons	

gallons (US)	*gal*	0.1337	cubic feet	*ft³*
gallons (US)	*gal*	128	ounces (US)	*oz*
grams	*g*	0.03527	ounces (avdp.)	*oz*
hectares	*ha*	2.471	acres	*ac*
horsepower		2545.08	BTU (mean)/hour	
inches	*in* or "	2.54×10^4	micron [= 10,000 Angstrom units (A)]	μ
inches	*in* or "	2.5400	centimeters	*cm*
kilograms	*kg*	2.2046	pounds (avdp.)	*lb*
kilometers	*km*	0.6214	miles (statute)	*mi*
joules	*J*	1×10^7	ergs	
liters	*l*	0.2642	gallons (US)	*gal*
liters	*l*	33.8143	ounces	*oz*
liters (= 1000 cm^3)	*l*	1.0567	quarts (US)	*qt*
long tons (2240 lb)		1.0160	megagrams	*Mg*
megagrams (= metric tons)	*Mg*	1.1023	short tons (2000 lb)	
megagrams	*Mg*	0.9842	long tons (2240 lb)	
meters	*m*	3.2808	feet	*ft* or '
meters	*m*	3.2808	feet	*ft* or '
meters	*m*	39.37	inches	*in*
micron	μ	1×10^{-4}	centimeters	*cm*
micron (=10,000 Angstrom units)	μ	3.9370 $\times 10^{-5}$	inches	*in* or "
miles (statute)	*mi*	1.6093	kilometers	*km*
miles/hour	*mph*	44.7041	cent./second	*cm/s*
miles/hour	*mph*	1.4667	feet/second	*ft/s*
milliliter	*ml*	0.0338	ounces	*oz*
1 milliliter ≈ 1 cm^3 = 1 gm (H_20, at 25°C)				
milliliter	*ml*	1.000028	cubic centimeters	*cm³*
millimeters	*mm*	0.03937	inches	*in* or "
ounces	*oz*	29.5729	milliliters	*ml*
1 milliliter ≈ 1 cm^3 = 1 gm (H_20, at 25°C)				
ounces (avdp.)	*oz*	28.3495	grams	*g*
ounces (avdp.) 1 troy oz. = 0.083 lb				
pints (US)	*pt*	473.179	cubic centimeters	*cm³* or *cc*
pints (US)	*pt*	0.4732	liters	*l*
pounds (avdp.)	*lb*	0.4536	kilograms	*kg*

quarts (US liquid)	*qt*	0.9463	liters (= 1000 cm^3)	*l*
rods (US)		0.25	chains (US)	*ft*
rods (US)		16.5	feet (US)	*ft*
short tons (2000 lb)		0.9072	megagrams (= metric tons)	*Mg*
square centimeters	cm^2	0.1550	square inches	in^2
square feet	ft^2	0.0929	square meters	m^2
square inches	in^2	6.4516	sq. centimeters	cm^2
square kilometers	km^2	0.3861	square miles	mi^2
square meters	m^2	10.7639	square feet	ft^2
square meters	m^2	1.1960	square yards	yd^2
square miles	mi^2	2.5900	square kilometers	km^2
square yards	yd^2	0.8361	square meters	m^2
yards	*yd*	0.9144	meters	*m*

Guide to Map Scales and Minimum-Size Delineations [1]

Order of Soil Survey	Map Scale	Inches Per Mile	Minimum Size Delineation [2]	
			Acres	Hectares
Order 1	1:500	126.7	0.0025	0.001
	1:1,000	63.4	0.100	0.004
	1:2,000	31.7	0.040	0.016
	1:5,000	12.7	0.25	0.10
	1:7,920	8.0	0.62	0.25
	1:10,000	6.34	1.00	0.41
Order 2	1:15,840	4.00	2.50	1.0
	1:20,000	3.17	4.00	1.6
	1:24,000 [3]	2.64	5.7	2.3
	1:30,000	2.11	9.0	3.6
Order 3	1:31,680	2.00	10.0	4.1
	1:60,000	1.05	36	14.5
Order 4	1:62,500	1.01	39	15.8
	1:63,360	1.00	40	16.2
	1:80,000	0.79	64	25.8
Order 5	1:100,000	0.63	100	40
	1:125,000	0.51	156	63
	1:250,000	0.25	623	252
	1:500,000	0.127	2,500	1,000
	1:750,000	0.084	5,600	2,270
	1:1,000,000	0.063	10,000	4,000
Very General	1:7,500,000	0.0084	560,000	227,000
	1:15,000,000	0.0042	2,240,000	907,000

[1] Modified from Peterson, 1981.

[2] Traditionally, the minimum size delineation is assumed to be a 1/4 inch square, or a circle with an area of 1/16 inches^2. Cartographically, this is about the smallest area in which a conventional soil map symbol can be legibily printed. Smaller areas can, but rarely are, delineated and the symbol "lined in" from outside the delineation.

[3] Corresponds to USGS 7.5-minute quadrangle maps.

COMMON SOIL MAP SYMBOLS (TRADITIONAL)

(From the National Soil Survey Handbook, Title 170, Part 601, 1990.) The following symbols are common on field sheets (original aerial photograph based soil maps) and in many soil surveys published prior to 1997. Current guidelines for map compilation symbols are in NSSH, Exhibit 627-5, 1997.

<u>SOIL DELINEATIONS</u> <u>SOIL SYMBOLS</u>

LANDFORM FEATURES

ESCARPMENTS 

Bedrock 

Other than bedrock

SHORT STEEP SLOPE

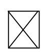
GULLY 

DEPRESSION, closed 

SINKHOLE 

EXCAVATIONS

PITS

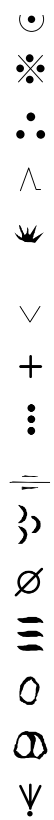
Borrow pit 

Gravel pit 

Mine or quarry 

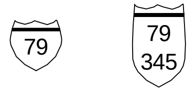
LANDFILL 

SOIL DELINEATIONS	SOIL SYMBOLS
MISC. SURFACE FEATURES	
Blowout	
Clay spot	
Gravelly spot	
Lava flow	
Marsh or swamp	
Rock outcrop (includes sandstone and shale)	
Saline spot	
Sandy spot	
Severely eroded spot	
Slide or slip	
Sodic spot	
Spoil area	
Stony spot	
Very stony spot	
Wet spot	

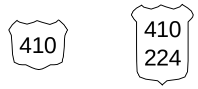


ROAD EMBLEMS &
DESIGNATIONS

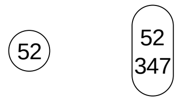
Interstate



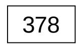
Federal



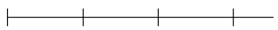
State



Country, farm or ranch



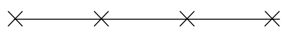
RAILROAD



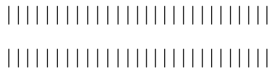
POWER TRANSMISSION LINE
(normally not shown)

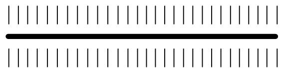
PIPELINE
(normally not shown)

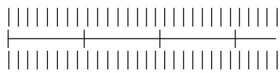
FENCE
(normally not shown)



LEVEES

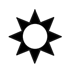
Without road 

With road 

With railroad 

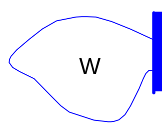
Single side slop 
(showing actual feature location)

LANDFORM FEATURES

Prominent Hill or Peak 

Soil Sample Site Ⓢ

DAMS

Medium or small 

STREAMS

Perennial, double line 

Perennial, single line 

Intermittent 

Drainage end 

SMALL LAKES, PONDS
AND RESERVOIRS

Perrenial water 

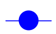
Miscellaneous water 

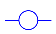
Flood pool line 

Lake or pond 

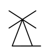
MISCELLANEOUS
WATER FEATURES

Spring 

Well, artesian 

Well, irrigation 

MISCELLANEOUS
CULTURAL FEATURES

Farmstead, house (omit in urban areas)	
Church	
School	
Other Religion (label)	 **Mt Carmel**
Located object (label)	 Ranger Station
Tank (label)	Petroleum
Lookout Tower	
Oil and/or Natural Gas Wells	
Windmill	
Lighthouse	

FIELD SAMPLING

Compiled by: P.J. Schoeneberger and D.A. Wysocki, NRCS, Lincoln, NE.

INTRODUCTION

This section contains a variety of miscellaneous information pertinent to the sampling of soils in the field.

Additional details of soil sampling for the National Soil Survey Laboratory (NRCS, Lincoln, NE) are provided in Soil Survey Investigations Report No. 42 (NRCS, 1996).

SOIL SAMPLING

The objective of the task determines the methodology and the location of the soil material collected for analysis. Sampling for Taxonomic Classification purposes involves different strategies than sampling for soil fertility, stratigraphy, hydric conditions, etc. There are several general types of samples and sampling strategies that are commonplace in soil survey.

SOIL SAMPLE KINDS -

Reference Samples (also loosely referred to as "grab" samples) - This is applied to any samples that are collected for very specific, limited analyses; e.g., only pH. Commonly, reference samples are not collected for all soil layers in a profile; e.g., only the top 10 cm; only the most root restrictive layer, etc.

Characterization Samples - These samples include sufficient physical and chemical soil analyses, from virtually all layers, to fully characterize a soil profile for Soil Taxonomic and general interpretive purposes. The specific analyses required vary with the type of material; e.g., a Mollisol requires some different analyses than does an Andisol. Nonetheless, a wide compliment of data (i.e., pH, particle size analysis, Cation Exchange Capacity, ECEC, Base Saturation, Organic Carbon content, etc.) are determined for all major soil layers.

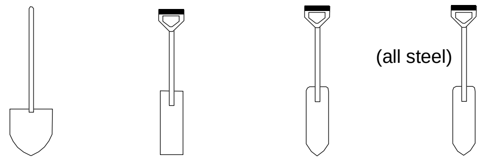
SAMPLING STRATEGIES - To be developed.

FIELD EQUIPMENT CHECKLIST -

Digging Tools (commonly choose 1 or 2) Bucket Auger Sharp Shooter Montana Sharp Shooter (for rocky soils) Tile Spade Spade (standard shovel) Push Probe (Backsaver®, Oakfield®) - include a clean-out tool Pulaski
Soil Description Knife Hand Lens (10X or combination lenses) Acid Bottle (1N - HCl) Water Bottle Color Book (Munsell®, EarthColors®, etc.) Picture Tapes (“pit tape” - metric preferred) Tape Measure (metric or English and metric) (3) Ultra-Fine Point Permanent Marker Pens Pocket pH Kit or Electronic “Wand” Pocket Soil Thermometer Camera Sample bags (for grab samples) Soil Description Sheet (232 or PEDON description form)
Site Description Field Note Book GPS Unit Abney Level Clinometer Compass Altimeter (pocket-sized)
Field References Field Book for Describing and Sampling Soils Aerial Photographs Topographic Maps (1:24,000, 7.5 min; 1:100,000) Geology Maps Soil Surveys (county or area) AGI Field Sheets
Personal Protective Gear Small First Aid Kit Leather Gloves Sunglasses Insect Repellent Sunscreen Hat

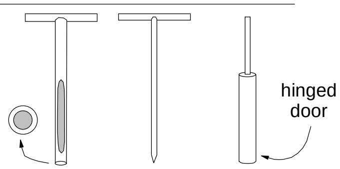
EXAMPLES OF COMMON FIELD SAMPLING EQUIPMENT - (Use of trade or company names is for informational purposes only and does not constitute an endorsement.)

Shovel Types



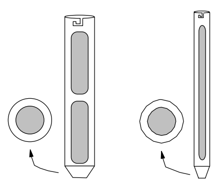
	standard shovel	tile spade	sharp-shooter	Montana sharp-shooter
Primary Use:	*most materials*	*loose material*	*most materials*	*rocky soil*

Soil Probes



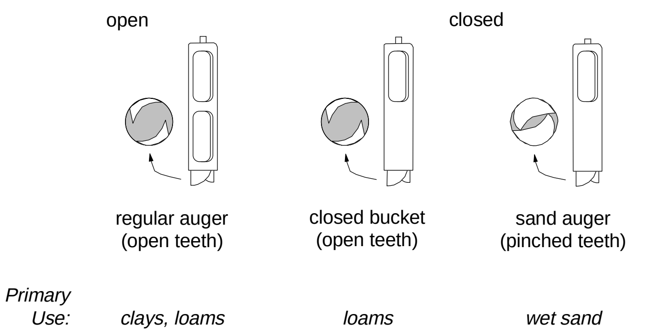
	regular push-tube	tile probe (solid steel rod)	peat sampler
Primary Use:	*fine earth*	*locating hard contact*	*organic soils*

Hydraulic Probes

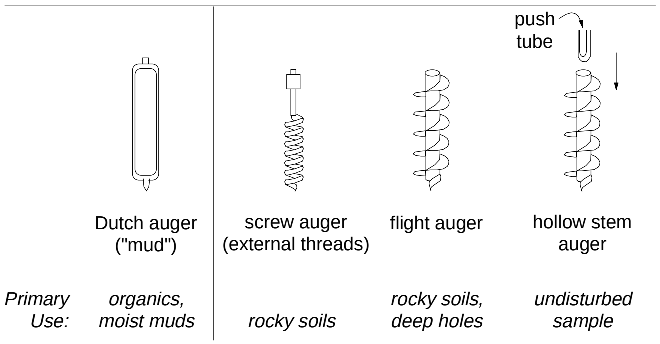


	Giddings tube	Bull probe
General Use:	*(not effective in high rock fragment materials)*	

Bucket Auger Types



External Thread Augers



REFERENCES

Soil Survey Staff. 1996. Soil survey laboratory methods manual. USDA - Natural Resources Conservation Service, Soil Survey Investigations Report No. 42, Version 3.0, National Soil Survey Center, Lincoln, NE. 693 pp.

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